INTERAVIA

WORLD REVIEW OF AVIATION AND ASTRONAUTICS

Price of this issue —

U.S.A.:	$ 1.00
British Isles:	4/6
South Africa:	6 s.
Rhodesia:	6/6
Switzerland:	Fr. 3.50
Germany:	DM 3.50
Denmark:	Cr. 6.25
France:	Fr. 400
Italy:	Lire 500
Japan:	U.S.$ 1.00
Netherlands:	Fl. 2.80
Sweden:	Cr. 4.40

IN THIS ISSUE

Focus on Ballistic Missiles

New U.S. Business Aircraft

Twelfth ICAO General Assembly

VOLUME XIV

No 7/1959

WORLD'S FASTEST

Convair 880 and 600 Jet-liners

YEARS AHEAD FOR YEARS TO COME

Superior speed is just one of the many exclusive features of the General Dynamics' Convair 880 and 600 Jet-Liners. The 880 and 600 are the *only* jet-liners that have the advantage of engines built by General Electric. With improvements in design that are as much as five years ahead of other jet transports now in production, Convair Jet-Liners offer assurance that advanced engineering and development will bring you jet travel that is *years ahead for years to come!*

CONVAIR
A DIVISION OF GENERAL DYNAMICS CORPORATION

First to offer Convair 880 or 600 Jet-Liner service will be TWA, DELTA, TRANSCONTINENTAL (Argentina), REAL-AEROVIAS (Brazil), S.A.S., SWISSAIR, AMERICAN

Volume XIV

INTERAVIA

July 1959

WORLD REVIEW OF AVIATION AND ASTRONAUTICS

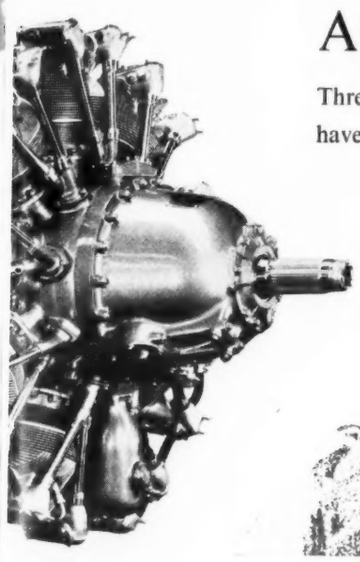
FOCUS ON BALLISTIC MISSILES

The Intercontinental Missiles Arsenal 807
The Prize-Winners in Interavia's Essay Competition 807
Nuclear Stategy and the Future . . . . . L. M. CHASSIN, PARIS 808
Manufacturing the Atlas at Convair 810
Development of a Modern ICBM—Testing the Titan 812
Operation SKYCATCH 817
Development Problems of Rocket Engines for Ballistic Missiles T. F. DIXON, CANOGA PARK 818
Inertial Guidance for Long-Range Aircraft and Missiles 822
Reliability in Inertial Systems . . . . . A. M. VOUTSAS & W. T. CHOW, NEW YORK 823
LINS—Lightweight Inertial Navigation System 824
British Missiles over the Australian Desert 835
Missile Testing in the Sahara 838
Roll-Out of the Northrop N-156F Fighter 840
Aero Commander and Gulfstream 841
A Medium-Calibre Mobile AA Battery 846
What's in the Air ? 848

THE SUMMIT OF CIVIL AVIATION — ICAO ASSEMBLY 862

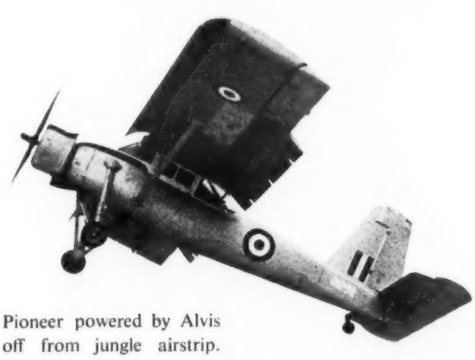
The Economic Field . . . . . E. M. WELD 862
Air Navigation . . . . . T. S. BANES 863
Legal Work of ICAO . . . . . P. K. ROY 865
The ICAO Technical Assistance Programme . . . . . E. R. MARLIN 864
An Enduring Institution of Peace . . . . . J. BERRIER 866
A Visit to the Federal Aviation Agency 866
Where NATO Scientists Work Together . . . . . K. K. PARROT, VOORBURG 869
Deadline Notes 779
Airlines of the Middle East 789
New York Finance Notes 790
International Meetings and Conferences 790

Front cover: *Test Launching of a Convair SM-65* Atlas *at Cape Canaveral.*



ACHIEVEMENT

Three years of service with the R.A.F. in Malaya
have proved the reliability of Alvis Aero Engines.
For minimum maintenance and maximum work
the R.A.F. rely on engines which have been *tried,*
tested and proved, where real work is done.



Scottish Aviation Pioneer powered by Alvis Leonides taking off from jungle airstrip.

ALVIS LEONIDES AERO ENGINES

ALVIS LIMITED COVENTRY ENGLAND

This is the
Murphy MR 380
Airborne Tape Reproducer
specified by BOAC
for use in their Boeing 707

The Murphy MR 380 is an airborne unit designed to play standard 2 track ¼-in. pre-recorded tapes over the aircraft Passenger Announcement Equipment. It has been specified by BOAC for their Boeing 707 aircraft to be delivered later this year. Here are the brief facts:

Frequency Response:	Level from 50—7000 c/s NARTB equalised.
Pre-Amplifier:	Plug-in, transistorised unit, removable for servicing.
Tape Transport:	By 28-volt governed motor giving automatic reversal at each end of tape, with manual over-ride for spool changing.
Spools:	7 in. diameter, giving 2 hours playing time at 3¾ ips.
Control:	Remote combined or independent ON-OFF switching and Gain Control. ON-OFF switch incorporates automatic fade in and fade out feature.
Size:	Standard ½ ATR long to ARINC characteristic 539.

The Murphy publication all about the MR 380 is yours for the asking.

keep in touch with murphy

Murphy Radio (Electronics Division), Welwyn Garden City, Herts.

INTERAVIA

WORLD REVIEW OF AVIATION AND ASTRONAUTICS

Editor-in-Chief and Publisher : E. E. HEIMAN

Managing Editor
H. RIECK

Technical Editors
E. BAUR, K. REGELIN

Editorial Staff
J. M. STROUD *(responsible for English Edition)*
E. HERZFELD *(responsible for German Edition)*
H. LAPIERRE *(responsible for French Edition)*
A. ARBEX *(responsible for Spanish Edition)*
P. HAUSHEER
R. G. RUDDICK

Administration
J. Vollenweider

Advertising
P. RUSSAK

Art Editors
H. W. MAHRER, O. FISCHER

Circulation
G. DENEKE

Offices :

Paris : Georges FÉVRIER (Manager); *London :* Derek WOOD (London Editor) *Rome :* Giorgio LOURIER (Manager); *Bonn/Rhein :* Arno L. SCHMITZ; *Washington :* Harry TENNANT (Editorial Director U.S.A.).

Correspondents :

Amsterdam : Henk A. JANSEN; *Antwerp :* Roger F. J. GILLYNS; *Athens :* Manos PAVLIDIS; *Bombay :* K. K. ANCHAN; *Johannesburg :* J. K. CHILWELL; *Linköping* (Sweden): Sven WALBERG; *Los Angeles :* Norman LYNN; *Madrid :* Luis SAENZ DE PAZOS; *Melbourne :* Kenneth GREEN; *Mexico City :* José VILLELA, Jr.; *Tokyo :* N. MATSUMURA; *Toronto :* M. WILLMOT; *Vienna* (and South East Europe): Max W. MORSTADT.

Agents :

Interavia Australasia 5, Tedstone Crescent, Balwyn E. 8., Victoria
Interavia Belgium 5, Heidestraat Noord, Kapellen-Anvers
Interavia Canada 25, Farmcote Rd., Don Mills, Ont.
Interavia France 144, Avenue des Champs-Elysées, Paris 8me
Interavia Germany Interavia Verlags-G.m.b.H., Koblenzer Str. 68, Bonn/Rhein
Interavia Great Britain 58, Fleet St., London, E.C. 4
Interavia Holland Henk A. Jansen, Olympiaplein 84, Amsterdam-Z
Interavia India No. 2 Gandhigram Rd., Juhu, Bombay
Interavia Italy 43, Via Latina, Rome 4.71
Interavia Japan Isogo P.O. Box 3, Yokohama
Interavia Mexico Ava. de los Alpes, 1030-6, Lomas de Chapultepec, Mexico 10, D.F.
Interavia South Africa P.O. Box 10242, Johannesburg
Interavia South East Europe Postfach 192, Vienna I./1
Interavia Spain Donoso Cortés 83, Madrid
Interavia Sweden P.O. Box 29, Linköping
Interavia U.S.A. 185, Madison Ave., New York 16, N.Y.
803, National Press Bldg., Washington 4, D.C.
James C. Galloway, 6535 Wilshire Blvd., Los Angeles 48, Calif

Distributors :

Austria	Morawa & Co., Wollzeile 11, Vienna I
Canada	Wm. Dawson Subscription Service Ltd., 587 Mount Pleasant Road, Toronto 12, Ont.
	Edward Company Regd., P.O. Box 98, Station Delorimier, Montreal P.Q.
Eire	Basil Clancy, Cooleevin, Foxrock, Co. Dublin
Finland	Akateeminen Kirjakauppa, Keskuskatu 2, Helsinki
	Rautatiekirjakauppa Oy, Köjdenpunojank 2, Helsinki
Germany	W. E. Saarbach G.m.b.H., Gertrudenstrasse 30, Cologne
Great Britain	W. H. Smith & Son, Ltd., Strand House, Portugal Street, London, W.C. 2
	Wymans Ltd., New Street Square, London, E.C. 4
Japan	Maruzen Co. Ltd., 6 Tori-Nichome Nihonbashi, Tokyo
Norway	A/S Narvesens Litteraturtjeneste, Postboks 115, Oslo
Uruguay	Humanitas, Colonia 883, Montevideo

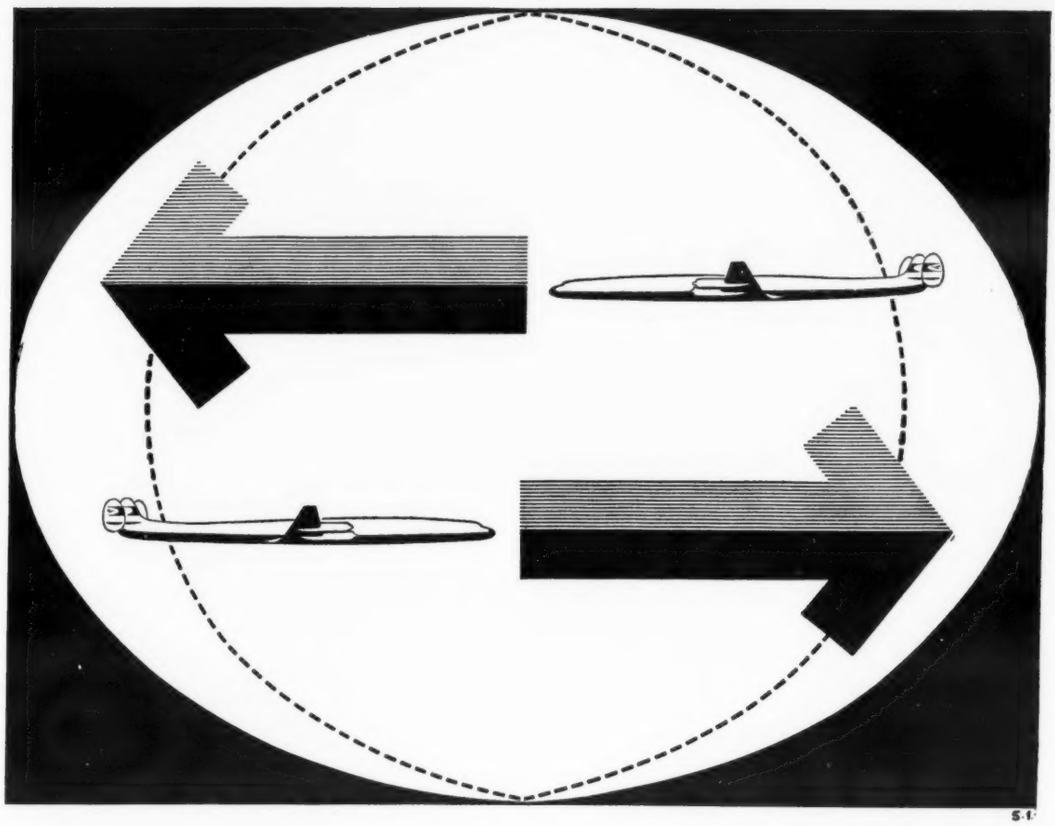
Advertising Department, Publishing and Editorial Offices, Subscription Department :

Interavia S.A., 6, Corraterie, Geneva. Telephone: 25 42 34 (five lines). Cables and Telegrams: Interavia-Geneva. Teleprinter: 22 122. Postal Cheque Account: Geneva I 5380.

Annual Subscriptions : U.S.A. and Canada, U.S.$ 9.00; United Kingdom and Eire, £2.12.6; Commonwealth, £2.12.6; Switzerland, 32.— fr.; Austria, 190.— sch.; Belgium, 370.— fr.; Denmark, 55.— kr.; France, 4200 fr.; Germany, 32.— DM; Holland, 28.— fl.; Italy, 4640.— L. it.; Japan, U.S. $9.00; Latin American countries, U.S. $9.00; Norway, 57.— kr.; Spain, 450.— pts.; Sweden, 40.— kr. All other countries, U.S. $9.00.

Appears Monthly in Four Editions : English, French, Spanish and German

Copyright 1959 by Interavia S.A., Geneva, Switzerland



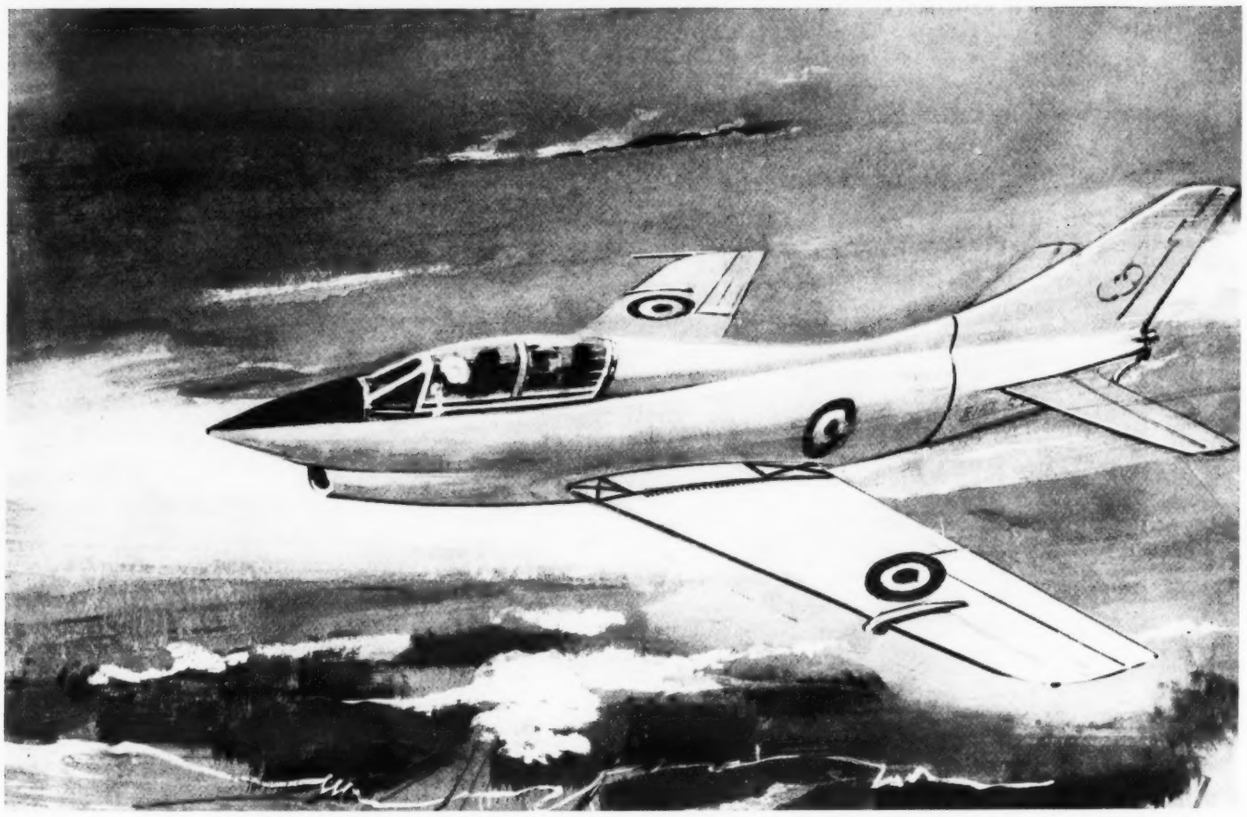
LUFTHANSA links the continents

Lufthansa serves : Athens • Baghdad • Barcelona • Beirut • Bremen • Brussels • Buenos Aires • Cairo • Chicago • Cologne/Bonn • Copenhagen • Dakar • Damascus • Düsseldorf • Frankfurt • Geneva • Hamburg • Hanover • Istanbul • Lisbon • London • Madrid • Manchester • Milan • Montevideo • Montreal • Munich • New York • Nice • Nuremberg • Paris • Rio de Janeiro • Rome • Santiago de Chile • Sao Paulo • Shannon • Stockholm • Stuttgart • Teheran • Vienna • Zürich

LUFTHANSA

THE FINEST SERVICE ON BOARD

FIAT
AVIAZIONE



FIAT'S NEW G.91 T

JET TRAINER

(Bristol Orpheus 80302 Engine)

— The transonic Jet-Trainer is derived from the G.91 lightweight strike fighter, winner of the NATO contest, and is specially designed for advanced training.

— The two-seat version has the same ability to operate from short grass runways or semi-prepared strips, the same manœuvrability even at low speeds, the same simplicity and low cost that are typical of the single-seat model.

FIAT - DIVISIONE AVIAZIONE
Corso Giovanni Agnelli, 200 - TURIN (Italy)

Caravelle

is in service on the European network of AIR FRANCE

PARIS-MILAN : 1 hr 20 min flight
PARIS-ROME : 2 hr flight
PARIS-ATHENS : 3 hr 50 min flight
PARIS-ISTANBUL : 5 hr flight

TOTAL SILENCE AT 500 MPH

AIR FRANCE

THE WORLD'S LONGEST ROUTE NETWORK

A FLEET OF 24 CARAVELLES WILL BE PROGRESSIVELY INTRODUCED ON THE WHOLE OF AIR FRANCE'S EUROPEAN NETWORK
CONSULT YOUR TRAVEL BUREAU OR THE NEAREST AIR FRANCE AGENCY. RESERVE YOUR SEAT IN TIME—TODAY

RECORD-BREAKING COPTERS

THE ALOUETTE = 6 world helicopter records including the all categories altitude mark of 36,089 ft. on June 13, 1958.
The first copter to reach the stratosphere.

Produced under license :
in the United States by
REPUBLIC AVIATION CORPORATION
and in Sweden by
S.A.A.B.

THE DJINN

All categories world helicopter altitude record of 27,860 ft.
on March 22, 1957.

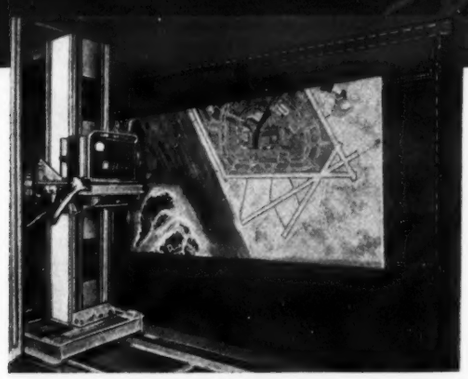
The only turbine-powered helicopters now in quantity production for all civil and military requirements.

In service all over the globe and in all climates.

MANUFACTURED BY

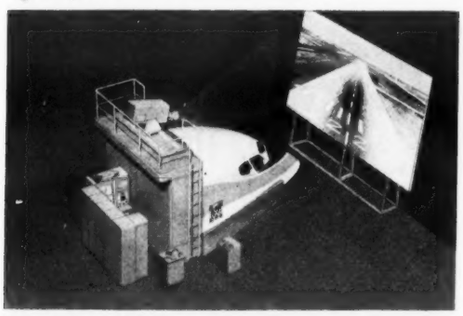
SUD AVIATION

37 - BOULEVARD DE MONTMORENCY - PARIS (16e) - TÉL. BAG. 84-00



▲ Responding to simulator controls, TV Camera scans scale model of any desired airport.

Airport is projected on wide screen to give pilot visual approach, landing, and take-off ▼ experience.



* *Visulator is the trademark of Curtiss-Wright Corporation*

SWISSAIR selects the VISULATOR* for its DC-8 and CONVAIR 880 Jet Simulators

Swissair—a veteran in simulator training for its precision operations over worldwide routes—now has added the most modern device in flight simulation: the Curtiss-Wright Dehmel Visulator. The Visulator system, which can be used with virtually all types of electronic simulators in use today, will serve both the DC-8 and Convair 880 simulators in the Swissair jet training program. The Visulator provides realistic VFR take-offs, approaches and landings by means of closed-circuit TV and a specially designed optical system. It simulates 10 square miles of airport and terrain with a 3-dimensional model just 8 by 17½ feet. Models of any airport in the world can easily be put into position. The system is "unprogrammed" —that is, the pilot is free to fly as he wishes, and what he sees is the result of his own actions. The Visulator responds accurately to all controls as the "aircraft" accelerates, rolls, pitches, climbs out . . . or encounters various weather or emergency conditions introduced by the instructor.

Curtiss-Wright Dehmel Simulators provide instrumentation, sound and motion. The new Visulator adds the final touch of realism—sight—to simulator training. Write for complete engineering data.

EXPORT DIVISION

CURTISS-WRIGHT

CORPORATION • 50 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

CURTISS-WRIGHT DEHMEL training equipment licensed under basic patents of R. C. DEHMEL AND CURTISS-WRIGHT. Canadian Licensee: Canadian Aviation Electronics Ltd., Montreal — British Licensee: Redifon Ltd., London — French Licensee: Societé d'Electronique et d'Automatisme, Paris

"The need for a high accuracy hyperbolic navigation system giving cover from ground level up to the highest altitudes used by commercial air transport is already being felt in some parts of the world, and it is the United Kingdom belief that the problems will become even more urgent when jet aircraft begin to operate in appreciable numbers. The United Kingdom is fully satisfied that the Decca Navigator System is potentially able to meet this need and the needs which will develop from the introduction of even higher performance aircraft, and believes the assertions it has made regarding the outstanding operational advantages conferred by the Decca System are unassailable."

Extract from the Final Statement by the United Kingdom Delegation at the Special Com/Ops/Rac ICAO meeting Montreal February 1959

THE DECCA NAVIGATOR

THE ONLY NAVIGATION SYSTEM CAPABLE OF MEETING THE OPERATIONAL REQUIREMENTS OF THE JET AGE

THE DECCA NAVIGATOR COMPANY LTD LONDON

Deadline Notes

European F-105 programme proposed : Speaking in Paris on June 18th, Republic Aviation Corporation President Mundy I. Peale proposed a joint European production programme for the Republic F-105D fighter-bomber for NATO air forces. Peale said that the F-105D, a 1,300 m.p.h. jet capable of delivering thermonuclear bombs and missiles, is scheduled to be the major all-weather strike aircraft in the USAF's Tactical Air Command, as well as for duty in Europe.

The Republic programme would establish a second source of supply in Europe by subcontracting production to various aircraft firms in the NATO countries. The programme would be set up under MDAP (with the U. S. underwriting some 20 percent of the total cost), and European production would be divided among the countries involved roughly in proportion to the number of aircraft ordered by each. By subcontracting, wings could be built in one country, engines supplied by a second, with still others participating in the supply of electronics and other equipment.

Peale said that a joint European production programme would avoid huge dollar defence expenditures by any one NATO nation and claimed that prompt action could see the first European-produced F-105D in service within two and a half years. An international project office would be established probably within the NATO structure; Republic would be technical manager of the programme, and a prime contractor would be selected in each participating nation.

●

Lockheed Aircraft Corporation officials have revealed a plan for joint European production of the C-130 *Hercules* turboprop transport, a scheme similar to that proposed for the Republic F-105. Lockheed spokesmen said that discussions have been initiated with western European nations towards this end, and preliminary conversations had stressed the advantages of such a joint enterprise : *Hercules* performance meets or exceeds most known European airlift requirements ; licence production would achieve major savings in manpower, cash and development time ; continued employment for national aircraft industries ; advanced technological experience available to participating nations with development of the boundary layer control version of the *Hercules*. The *Hercules* could be in active service by 1961.

An exchange of technical staff between participating nations and Lockheed's Georgia Division would expedite production and broaden the scope of European firms' design experience.

●

European Hawk production programme : A specialized agency has been set up by NATO to " coordinate and direct " the quantity production of *Hawk* surface-to-air missiles in Europe. The agency will consist of a committee comprising representatives of the five countries concerned in the programme (Belgium, France, Germany, Italy and the Netherlands). Meanwhile, five major European manufacturers—Ateliers de Constructions Electriques de Charleroi (Belgium), Thomson Houston (France), Telefunken (Germany), Finmeccanica (Italy) and Philips (Netherlands) — have pooled their production resources under a new company to be known as Société Européenne de Téléguidage (SETEL). General and technical management of the company will be in the hands of France's Thomson Houston.

●

SEREB (Société d'Etudes et de Recherches sur les Engins Balistiques) is a new company which has been established in Paris to centralize research in the field of rocket engines on behalf of Sud Aviation, Nord-Aviation, Marcel Dassault, SEPR and MATRA. Chairman of the new company is Charles Cristofini, currently Deputy Secretary General of Western European Union ; Cristofini will be assisted by a Technical Director, Fernand Vinsonneau, Technical manager at Sud Aviation.

The list of participating manufacturers is not yet final, and it is expected that one or two of France's major precision engineering firms and other European concerns will also participate. Finally, it is likely that an American company will also participate in the new company, with a capital contribution in the form of licence production rights.

●

Grumman Aircraft Engineering Corporation has delivered a *Gulfstream* twin-turboprop executive aircraft to the Sinclair Refining Company, the first of 40 companies to take delivery of the 10-12 passenger aircraft. Grumman is producing the *Gulfstream* at the rate of three per month, and the Sinclair aircraft is the fourth model off the production lines. Aircraft numbers one and two are production prototypes, and the third is being used by Grumman for demonstrations.

●

The Hawker Siddeley Group has formed a Central Advanced Projects Unit to concentrate on design work in the fields of supersonic transports, manned and unmanned vehicles, and various aspects of astronautics. The new unit will be headed by J. C. Floyd, designer of the Avro *Arrow*, and will be staffed by key personnel from the Group's operating companies, including Avro Aircraft of Canada. Floyd, who is a Director and Vice President-Engineering of Avro Canada, has been recalled from Canada to head the unit, with headquarters at Kingston-on-Thames. He will be directly responsible to Hawker Siddeley Aviation Ltd. Technical Director Stuart Davies, and his team is to have top priority in the company's future activities.

●

Technitron Verkaufs-GmbH of Frankfurt took over representation in Germany, Switzerland and Austria for Columbia Commerce & Credit Corporation's Aviation Division, on June 1st. Technitron has sales agencies for: Aeromaritime Inc. (Washington D. C.), R. C. Allen Aircraft Instrument Division (Grand Rapids, Michigan), Kollsman Instrument Corporation (Elmhurst, N.Y.), Leach Corporation (Los Angeles, California), Lewis Engineering Company (Naugatuck, Connecticut), The Reflectone Corporation (Stamford, Connecticut), Filotecnica Salmoiraghi S.p.A. (Milan, Italy), and Murphy Radio Ltd. (Welwyn Garden City, England).

●

Novotechnik GmbH, of Ruit near Stuttgart, has built West Germany's first industrial test bench for jet engines of up to 1,100 pounds thrust. The equipment has been built for Ernst Heinkel AG, and is scheduled to come into operation very shortly ; the Heinkel company is responsible for servicing the West German Air Force's Turboméca *Marboré II* powerplants (Potez-Air Fouga CM.170R *Magister*), the *Artouste II* (Sud Aviation *Alouette II*) and *Palouste IV* (Sud Aviation *Djinn*). Novotechnik is currently working on a test bench for units with considerably higher thrust, for BMW Triebwerkbau GmbH at Munich-Allach.

●

Fairchild Engine and Airplane Corporation has reopened its aircraft modification plant in St. Augustine, Florida. Closed in December, 1958, the 125,000 square foot plant will be used for progressive maintenance and component overhaul of the R4Y (Convair 340) called for in a new contract awarded to Fairchild by the Bureau of Aeronautics, U.S. Navy. The company anticipates that approximately 175 persons will be employed at the facility in the near future, and that only supervisory personnel will come from its Hagerstown facility.

●

André Edouard Turcat, Nord-Aviation Chief Test Pilot, has been awarded the 1959 Harmon International Aviation Trophy ; Turcat was the first test pilot to achieve speeds of over Mach 2 (in the Nord-Aviation 1500 *Griffon* experimental aircraft, with a combination turbine and ramjet powerplant). During this flight, Turcat achieved an altitude of over 60,000 feet.

●

Hawaiian Airlines Ltd. has joined the International Air Transport Association as an associate member. Total IATA membership is now 89 carriers, 80 active and 9 associate members.

●

IATA's London Clearing House recorded a 23 percent increase in settlements for the first quarter of 1959. Total clearance for the quarter was $195,326,000 (£69,516,000), compared with $158,949,000 (£56,468,000) for the first three months of 1958. The necessity for cash payment was eliminated in 87.9 percent of all transactions cleared during the quarter. Interclearances between the IATA Clearing House and the Airline Clearing House Inc. in the USA totalled $7,635,596 for the quarter, up 18 percent on 1958 ; the offset ratio averaged 92 percent.

Two more member airlines joined the Clearing House during the period : Ethiopian Airlines Inc. and Turkish Airlines Ltd. (THY).

●

Air Union plans to open local offices in Vienna, Graz, Innsbruck, Klagenfurt, Linz and Salzburg by spring 1960 at the latest, Sabena's Public Relations Manager has told the Austrian press. This can be read as an indication of Air Union's considerable interest in the feeder value of Austrian Airlines' proposed domestic network and connections to external cities, particularly Trieste.

●

Alitalia appears likely to order Sud Aviation *Caravelles* for operation on medium stage routes. It is reported from Rome

that all the Air Union member carriers will adopt the *Caravelle* for this role, and Alitalia is believed to have opened discussions with Sud Aviation and Air France on this subject, to ensure that the carrier has at least some medium-haul jet aircraft available for service within the next few months. An official statement is expected in the near future.

●

KLM, Royal Dutch Airlines has placed an order with Douglas Aircraft Company for an additional four Douglas DC-8s. This will bring KLM's DC-8 fleet strength up to twelve.

●

Philippine Air Lines is planning to resume the international services which were suspended five years ago, utilizing a $12,000,000 appropriation awarded in a bill signed by President Garcia on June 5th. A PAL spokesman has said that the carrier expects to resume Manila-San Francisco flights in January 1961, following the delivery of two Douglas DC-8s late next year.

●

Britain's Ministry of Supply has announced that it will order three Handley Page *Dart Heralds* and three Hawker-Siddeley Aviation Avro 748s. The Ministry considers that the aircraft's commercial prospects would be improved by an early demonstration of their efficiency in regular operation on normal services in the United Kingdom. The *Heralds* will be leased to BEA for trials on the latter's Scottish routes, and it is believed that the Avro 748s will go to RAF Transport Command for proving. This order marks a new departure in the policy for providing Government support for civil aircraft manufacturers.

●

The U.S. Navy is building a new radio telescope at Sugar Grove, West Virginia. The telescope, which is expected to be the world's largest movable structure, is to have a dish antenna 600 feet wide by 200 feet long, and is scheduled for completion in 1962. The equipment will be capable of picking up signals from a 19 times greater range than the 200-inch reflecting telescope at Mt. Palomar, California.

●

Quebecair Inc. has ordered a third Fairchild F-27 for services in the province of Quebec and eastern Canada. The first two F-27s were delivered in October, 1958.

●

Nord-Aviation has granted Bölkow Entwicklungen KG exclusive commercial rights in the Federal German Republic for the Nord 5103 air-to-air missile, under an agreement signed in November, 1958 and covering collaboration in the study, development and production of missiles for the French and German governments. Under the agreement Bölkow also acquires rights for research and development work on the necessary aircraft and ground support equipment for the West German Air Force.

●

The Martin Company has announced the formation of its Activation Division, to operate as integrating contractor for the operational *Titan* weapons system in the field, under direction of the Air Force Ballistic Missile Division. General Manager of the new division is Vernon Rawlings, who has been with the company since 1939.

●

An International Academy of Aviation Medicine was founded at Los Angeles in April, 1959. With a central administration at Brussels, this worldwide organization comprises 200 highly-qualified doctors specializing in aviation medicine. The academy will make a full and independent study of all problems affecting aviation and astronautical medicine and will advise international bodies (such as ICAO and WHO), governments, and companies on these matters.

Workshop Briefs

A new world record over 100 km was set up by a Dassault *Mirage III* at Melun-Villaroche on June 19th, 1959. Test Pilot Gérard Muselli reached an average speed of 1,095 m.p.h. The earlier record of 1,018 m.p.h. was set by André Turcat in a Nord *Griffon* on February 25th, 1959.

●

During the test flights which have been made over a considerable period of time with the Breguet 940 experimental STOL aircraft, exceptionally high performance figures were obtained on repeated occasions. Given below are the latest data available for the Breguet 940. With a take-off weight of 14,680 lb and a total engine power of 1,600 h.p., a 50-ft obstruction could be cleared after 623 ft ; the take-off run was 279 ft., rate of climb immediately after take-off 1,380 ft/min. These figures are thus considerably higher than those stipulated in the contract, which were : 820 ft over a 50-ft obstruction and 984 ft/min. — During demonstration flights at Toulouse on May 20th, the Breguet 940 required a landing distance of only 1,310 ft over a 50-ft obstruction, touch down and take off again to clear the same 50-ft obstruction.

●

Two MATRA R.511 missiles, complete with warheads, were fired for the first time during the latest series of missile tests at Colomb Béchar. Both were launched from a *Vautour* aircraft and both reached their target, a Nord CT.20 drone, which was flying at Mach 0.9. The two *Parca* missiles fired during the same series of tests also hit their targets (CT.10 drones). — Details of the MATRA R.511 air-to-air missile are as follows : diameter 10.24 in, overall length 122 in, launching weight 397 lb. The R.511 has two wings with a total span of 3.28 ft at the rear of the airframe, two stabilization vanes mounted forward of the wings (canard configuration) and a fin at the lower rear of the missile. The missile is powered by a two-stage Hotchkiss-Brandt solid-propellant rocket.

●

A new CJ-810 turbofan engine in the thrust class 7,000 to 9,000 lb for short to medium range transports has been announced by General Electric Company. The engine has an aft fan and appears to be basically a scaled-down model of the CJ-805-23.

●

Aviation Traders, Air Charter's associated company, will convert ten DC-4s to a car-ferrying role, and these aircraft—to be known as ATL.98—will be used by Air Charter for their considerably expanded car ferry services. The DC-4 fuselage forward of the wings will be removed and replaced by an entirely new section with nose-loading door and raised cockpit above the freight hold. On the other hand, the DC-4 cockpit layout, controls and nosewheel will be retained. The ATL.98 will carry up to five cars and 25 passengers, the latter in the rear of the cabin. Cruising speed will be 260 m.p.h. (175 knots). Price of a fully-converted ATL.98 is likely to be about £140,000.

●

A new twin-turboprop transport, the Aerfer *Ae.150,* can be used for either civil or military purposes and can be built at low cost and within a short period of time. It is powered by two Rolls-Royce *Dart RDa.10s* (2 × 2,660 e.h.p.). The main data for the *Ae.150* are as follows : Span 107.1 ft, length 78.7 ft, wing area 1,237.85 sq.ft, aspect ratio 9. Weight equipped 22,620 lb, gross weight 36,380 lb. — Performance : max. speed 232 knots, or 171 knots on one engine ; take-off speed 45 knots ; climb to 13,120 ft in 7 min 30 sec ; service ceiling 31,820 ft or 15,750 ft on one engine ; take-off distance to clear a 35-ft obstruction 525 ft ; landing distance over a 50-ft obstruction 656 ft.

●

Representatives of Omnipol, the Czechoslovak State trading organization, have announced details of a new aircraft engine, designated M.337. It is an air-cooled six-cylinder in-line engine with supercharger and direct fuel injection. — Take-off rating is 210 h.p. at 2,750 r.p.m.; rated power 170 h.p. at 2,600 r.p.m.; max. cruising power 140 h.p. at 2,400 r.p.m.; cruising power at altitudes of between 3,280 and 6,560 ft is 115 h.p. to 140 h.p. at 2,300 r.p.m. to 2,400 r.p.m. — Main dimensions : length excluding propeller hub 55.51 in, width 18.42 in, height 24.72 in, bore 4.13 in, stroke 4.52 in, swept volume 364.3 cu.in, compression ratio 6.3:1.

●

The Lockheed Aircraft Corporation's four-engine *JetStar* (four Pratt & Whitney JT-12s or J60s) is now being offered in a special version for aerial photographic survey work, equipped for a crew of five.

●

The new Turboméca Marboré VI jet has a thrust of 1,060 lb for an installed weight of 313 lb ; overall length 55.57 in, diameter 22.33 in, consumption 1,185 lb/h for the take-off thrust of 1,060 lb, max. continuous power 925 lb with a consumption of 1,082 lb/h. It has the same installed dimensions as the II version.

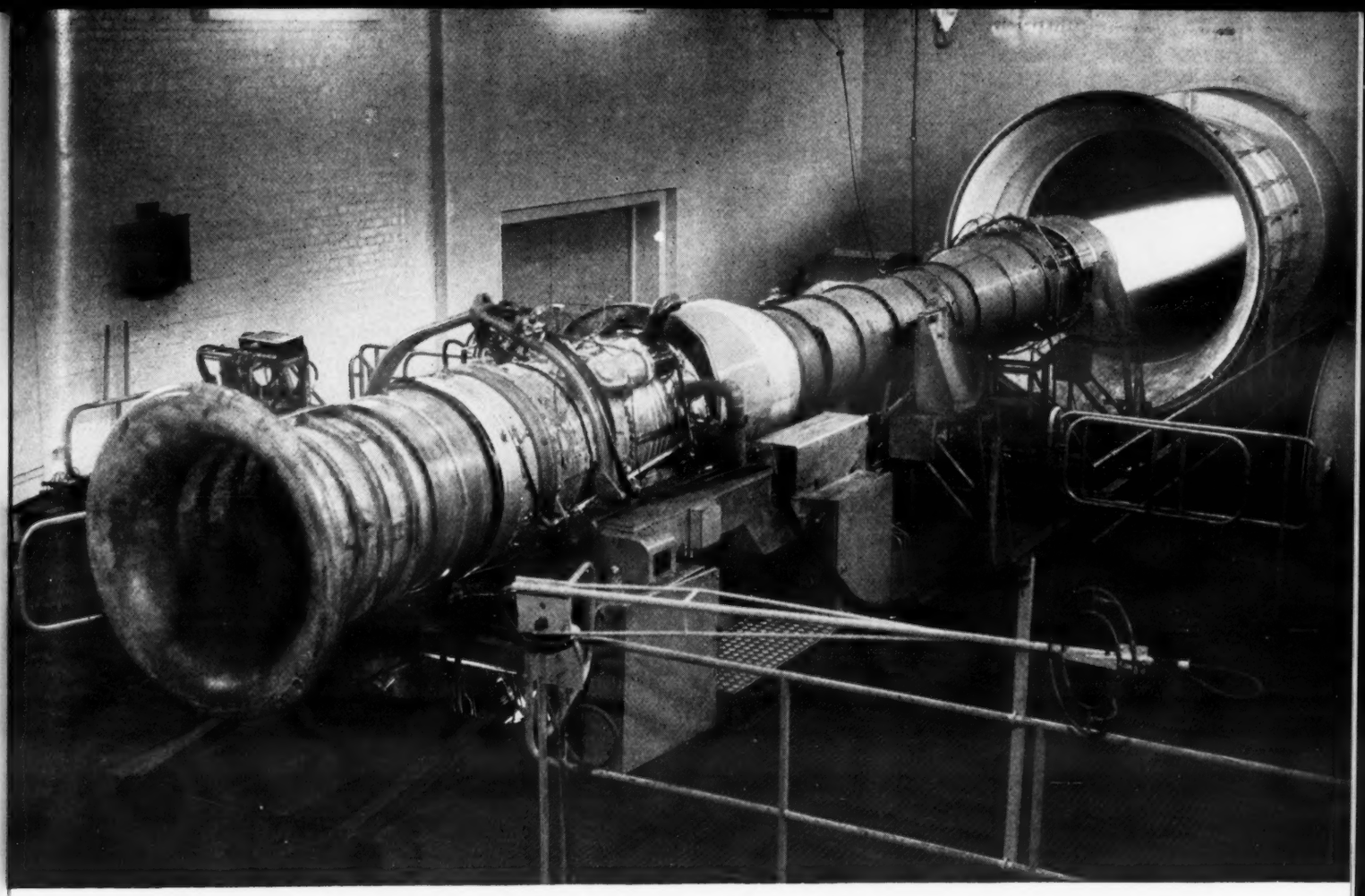
●

The latest helicopter design from Bristol is the type 214, a 16-seater with two de Havilland Gnome engines.

●

Short is reportedly developing the Hurel Dubois wing layout for the new light freighter project, which was previously being developed by Miles at Shoreham with the HDM.106. It appears that Miles has transferred its interest to Short.

Photo credits : Front cover : Convair ; pp. 808-810 : manufacturers (4), Interavia files (1) ; pp. 810-811: manufacturers ; pp. 812-816 : manufacturers (10), Interavia drawing (1) ; p. 817 : manufacturers ; pp. 819-821 : manufacturers (7), U.S. Army (1) ; pr. 822 : manufacturers ; p. 823 : manufacturers ; p. 824 : manufacturers ; pp. 835-837 : Crown Copyright (1), WRE, Salisbury, S. A. (2), Australian News & Information Bureau, London (2), manufacturers (2) ; pp. 838-839 : Ministère des Armées "Air" (4), manufacturers (4) ; p. 840 : manufacturers ; pp. 841-845 : Levy-Shipp (3), manufacturers (13) ; pp. 846-847 : manufacturers ; pp. 848-850 : M. Zegler (2), manufacturers (11), Interavia (1) ; pp. 862-866 : ICAO ; pp. 866-870 : FAA ; pp. 869-870 : author ; p. 789 : Interavia.



Bristol Siddeley Olympus delivers

24,000-lb thrust

Reheat version more than doubles power output of less than three years ago; demonstrates great potential of the Olympus design.

Less than three years ago the Olympus Mk 101 entered RAF service as the powerplant of the Avro Vulcan and was rated at 11,000 lb dry. Rapid development soon resulted in the Mk 200, producing 16,000 lb dry; while today's Mk 201, selected for the improved Vulcan B Mk 2, develops 17,000 lb dry, and 24,000 lb with Bristol Solar fully variable reheat—in still more advanced versions, will be increased to around 30,000 lb

Olympus design not only gives high power for low weight. As Vulcan performance clearly illustrates, it secures three further valuable advantages.

1. Great power at great height. The Olympus maintains a high cruising thrust for the Vulcan at altitudes above 50,000 ft.

2. Low fuel consumption. The Olympus gives the Vulcan immense flight duration. It has flown the Atlantic non-stop, from Farnborough to Toronto—3,566 miles—against the prevailing winds, at a point-to-point speed of well over 500 mph.

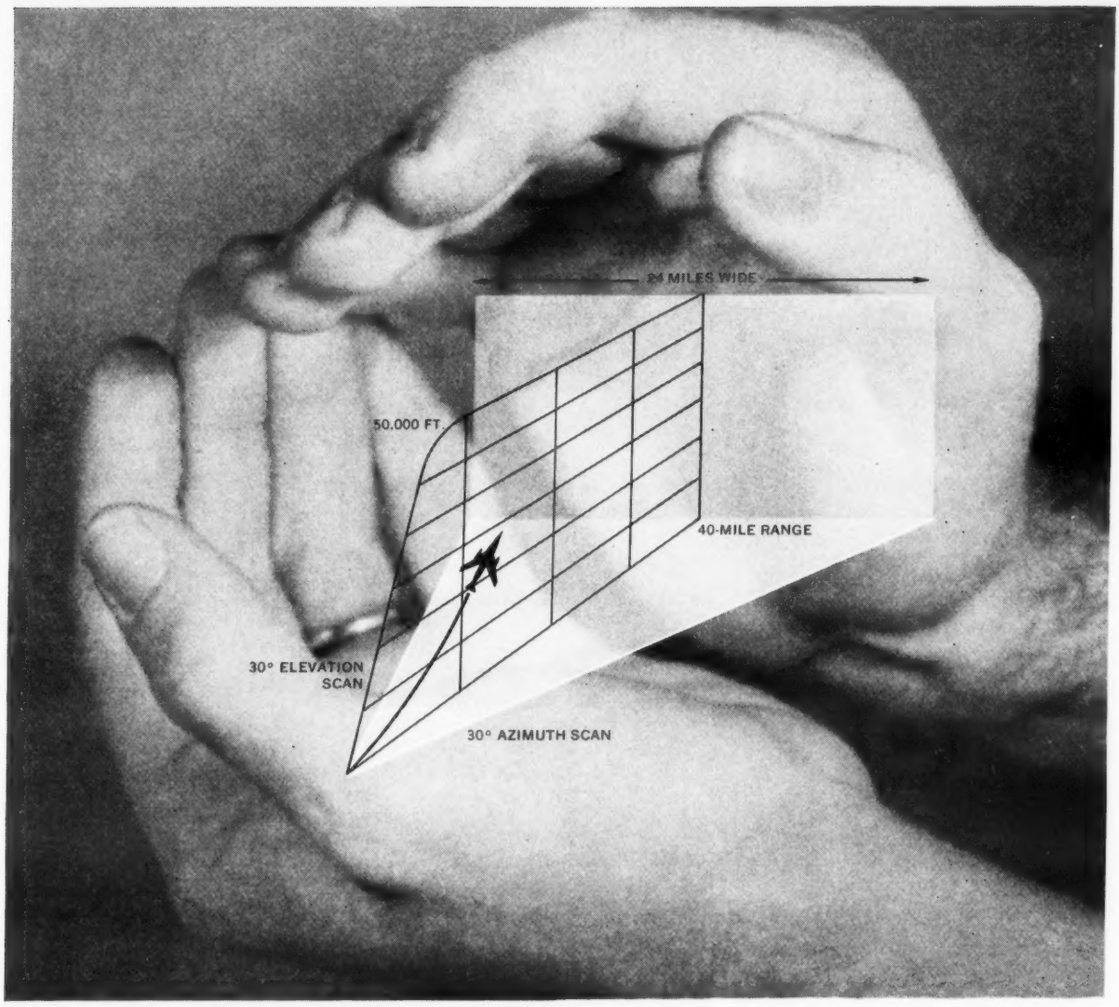
3. Outstanding reliability. In a series of overseas flights, UK-based Vulcans have flown as far afield as the United States, Rhodesia, South America and New Zealand, to pre-arranged schedules. Such was the confidence in the Olympus, that, on the great majority of these flights, no provision was considered necessary for any engine spares whatsoever away from the aircraft's home base.

The handling characteristics of the Olympus have also received the highest praise. According to an official report, ". . . the Olympus sets a standard of handling at altitude which has never been equalled by any other turbine engine."

Latest achievement in the Olympus story is its selection as powerplant for the new TSR-2 strike reconnaissance aircraft.

Bristol Siddeley

ENGINES LIMITED



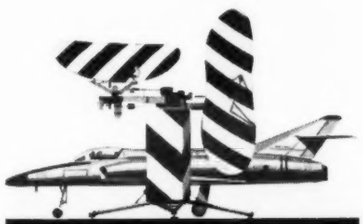
Gilfillan Quadradar first proven navigational aid for the safe handling of supersonic jet aircraft!

Versatility and reliability of the Gilfillan Quadradar has been proven for over two years in more than 150 installations around the world! Gilfillan Quadradar has a three-dimension approach and departure coverage 40 miles long, a 24-mile wide "gate" and altitude coverage of 50,000 feet to permit a straight-in jet penetration and safe high-angle climb-outs.

Quadradar's 360-degree surveillance and height-finder system permits rapid, tight three-dimension control of traffic patterns within an area of 5,000 square miles. Pilots can be informed of position of all other aircraft within the terminal area, reducing collision hazards. Using its jet penetration function in reverse, Quadradar provides safe control during Mach plus high-angle climb-out, even in high-density traffic. The versatility and terminal area safety features during penetration and high-angle, high-speed climb-outs of jet aircraft have been established by the U.S. Navy, the U.S. Air Force and by Lockheed, Douglas, Convair, North American and Hughes Aircraft Companies in actual operation at Moffett NAS, Castle AFB, and at Palmdale Flight Test Center.

Quadradar's unique versatility is providing air traffic controllers with accurate, safe altitude separation, monitored TACAN approaches, thunderstorm avoidance, and multiple runway coverage. It is also used as a toss-bomb trainer.

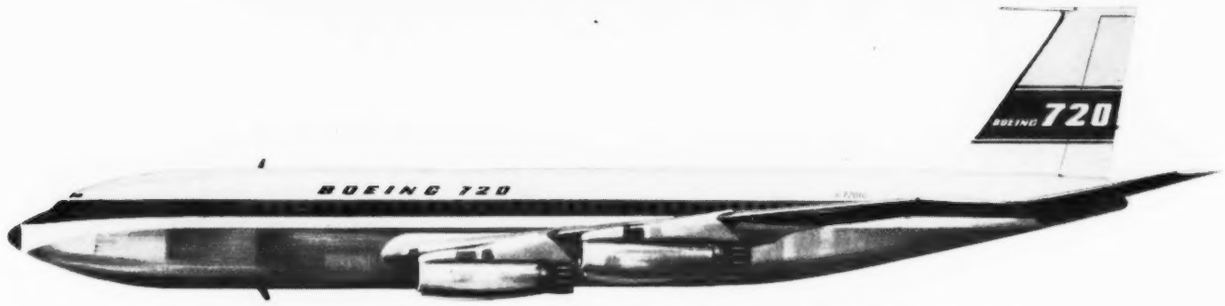
Gilfillan's manufacturing experience since 1912 and creative capabilities in the fields of Air Navigation, Radar Trainers and Ground Support Equipment, Electronic Countermeasures, Missile Systems and Instrumentation, are available for complete research, development and production in these and related fields.



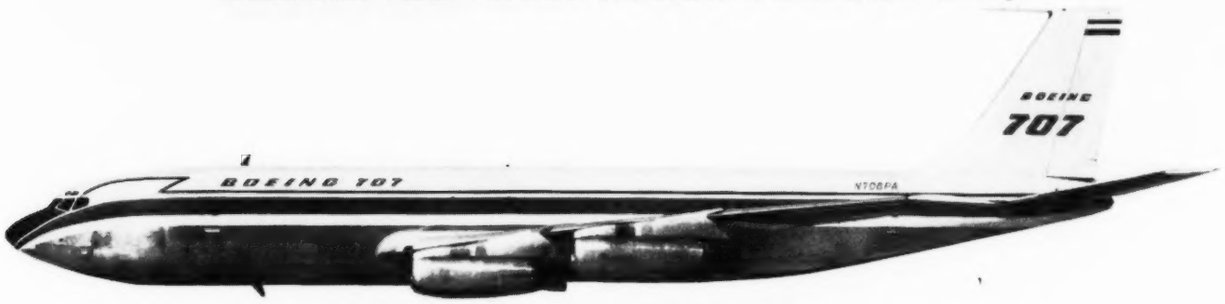
Gilfillan
LOS ANGELES

Seven Gilfillan Plants in Southern California / Headquarters : 1815 Venice Blvd., Los Angeles, Calif.

Quadradar is distributed outside the United States by
RCA International Division, 30 Rockefeller Plaza, New York, New York.
For details, contact your local RCA Int. distributor.



BOEING 720 SHORT-TO-MEDIUM RANGE (drawing)



BOEING 707 MEDIUM-LONG RANGE

BOEING 707 *Intercontinental* VERY LONG RANGE

Airline profit-makers

The Boeing jetliners shown above are designed for profitable operations over all airline routes, from short intercity segments to very long overocean stages.

Their outstanding earning power has already been demonstrated by the 707. Since going into service last October, this Boeing jet has attracted unprecedented load-factors of 90 to 95%. Operators describe it as the most popular airliner in aviation history.

Later this year the 707 Intercontinental — the world's longest-range jetliner — will begin commercial operations. With a range of more than 5000 miles with full passenger payload, it will fly nonstop over the longest stages of airline routes, at cruise speeds above 600 miles an hour.

The 720 is the fastest airliner of its class, with a cruise speed of 614 miles an hour.

Backed by Boeing's unequalled multi-jet experience, the 720 is an extremely versatile jetliner able to operate profitably over short intercity and medium-range routes.

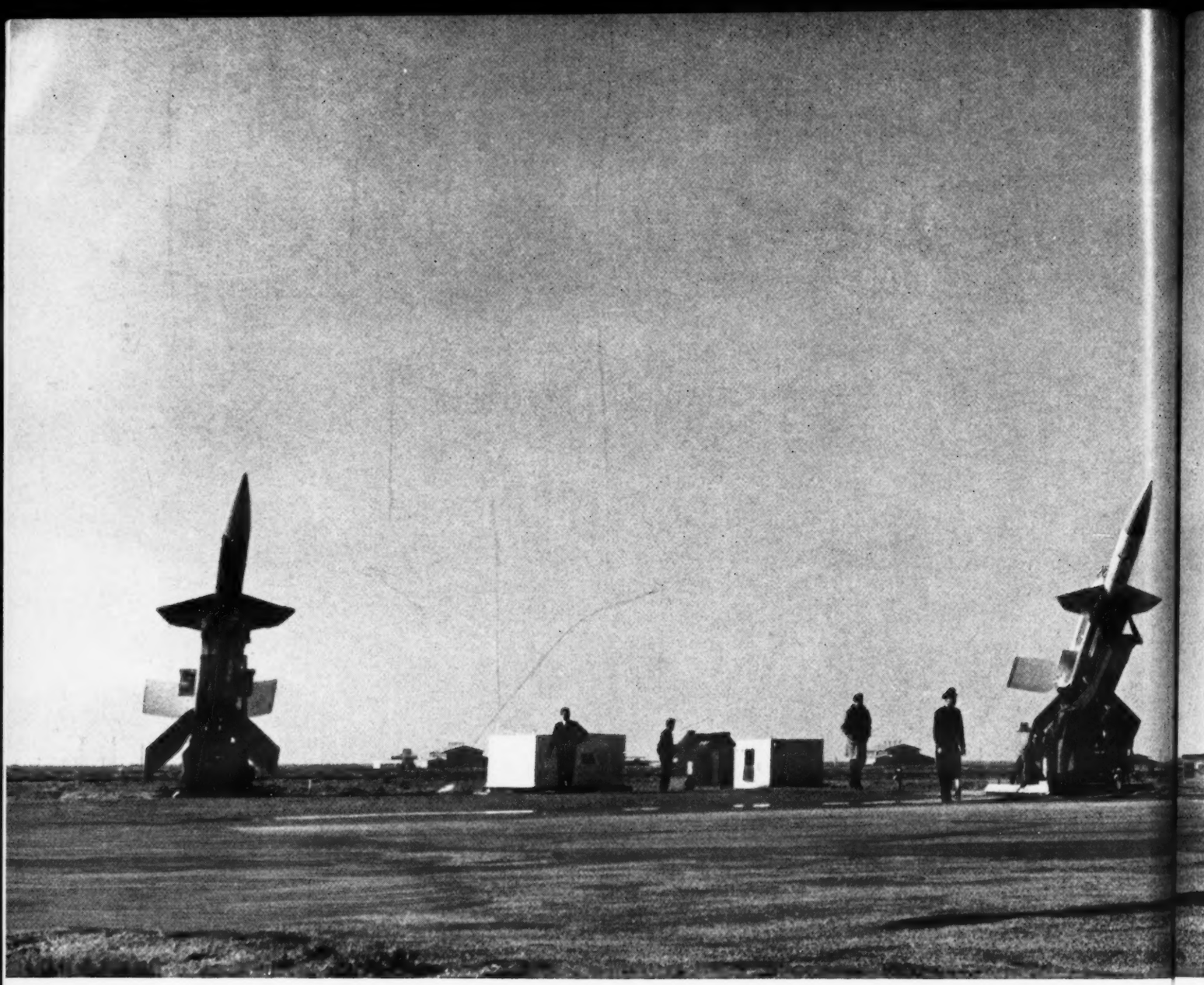
Boeing jetliners now in scheduled service are demonstrating tremendous earning power, extremely high initial utilization and unprecedented public acceptance.

These airlines have already ordered Boeing jets:

AIR FRANCE · AIR INDIA
AMERICAN · B.O.A.C.
BRANIFF · CONTINENTAL
CUBANA · IRISH · LUFTHANSA
PAN AMERICAN
QANTAS · SABENA
SOUTH AFRICAN · TWA
UNITED · VARIG · Also MATS

BOEING

family of jetliners



Bloodhounds ready for launching during acceptance trials at Woomera

EFFECTIVE

More advanced Bloodhound for defence of U K confirms particular suitability for European defence needs

Already in operational service with the RAF and adopted by non-NATO Sweden, Bloodhound Guided Weapons System is now to be further developed for the RAF.

This developed Bloodhound possesses substantially increased operating range and altitude, with advanced technique ensuring still greater lethality at these increased ranges and heights. Low altitude performance is further improved to counteract the threat of low-flying targets.

Development, rather than replacement, of Bloodhound offers the obvious economic and operational advantages inherent in making use of an existing system.

Proved in many hundreds of test firings; built by Europe's largest missile-manufacturing complex; and particularly suited to European defence needs, Bristol/Ferranti Bloodhound forms *the world's most effective defence system now and for many years to come.*

WEAPON DESIGN AND CONSTRUCTION BY BRISTOL • GUIDANCE AND CONTROL BY FERRANTI

CROWN COPYRIGHT RESERVED

DEFENCE

Security forbids publication of full details, but the following facts about Bloodhound can now be given:—

Power. The Bloodhound is powered by two Bristol Siddeley ramjets—jet engines with no moving parts. Ramjets ensure power and range flexibility, burn kerosene, are simple and safe to handle.

Homing System. Semi-active: i.e., ground crew directs radar beam on to target, which is reflected to a receiver in Bloodhound, ensures highest accuracy—regardless of range. Missiles may be fired, singly or in salvoes, using only one radar.

Airframe. Employs unique and advanced monoplane moving wing configuration—two advantages: quicker and more precise response, as well as greater accuracy of interception; superior at high altitudes. This configuration was selected at initial design stage to embody maximum development potential.

BRISTOL/FERRANTI

Bloodhound

GUIDED WEAPON SYSTEM

TARGET ILLUMINATING RADAR BY BTH · SYSTEM SALES ORGANISATION BY BRISTOL AIRCRAFT LIMITED

At airports 'round the earth...

'Jeep' vehicles are doing the world's work!

'Jeep' Cargo Belt Loader
Unique front elevation... designed to minimize manual lifting. The only vehicle of its kind.

Preferred by Major Airlines Around the World!

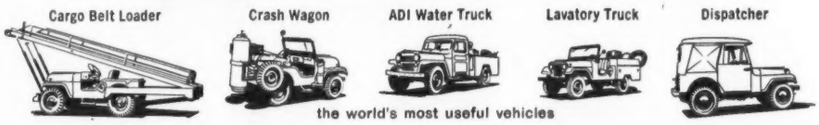
- compact 'Jeep' vehicle units save space and manpower.
- mobile power from *three* power take-off points saves use of other equipment.
- 4-wheel drive 'Jeep' vehicles go *anywhere*...anytime ...in any *weather!*

Contact your local 'Jeep' distributor or dealer for a demonstration on your job.

WILLYS-OVERLAND EXPORT CORPORATION

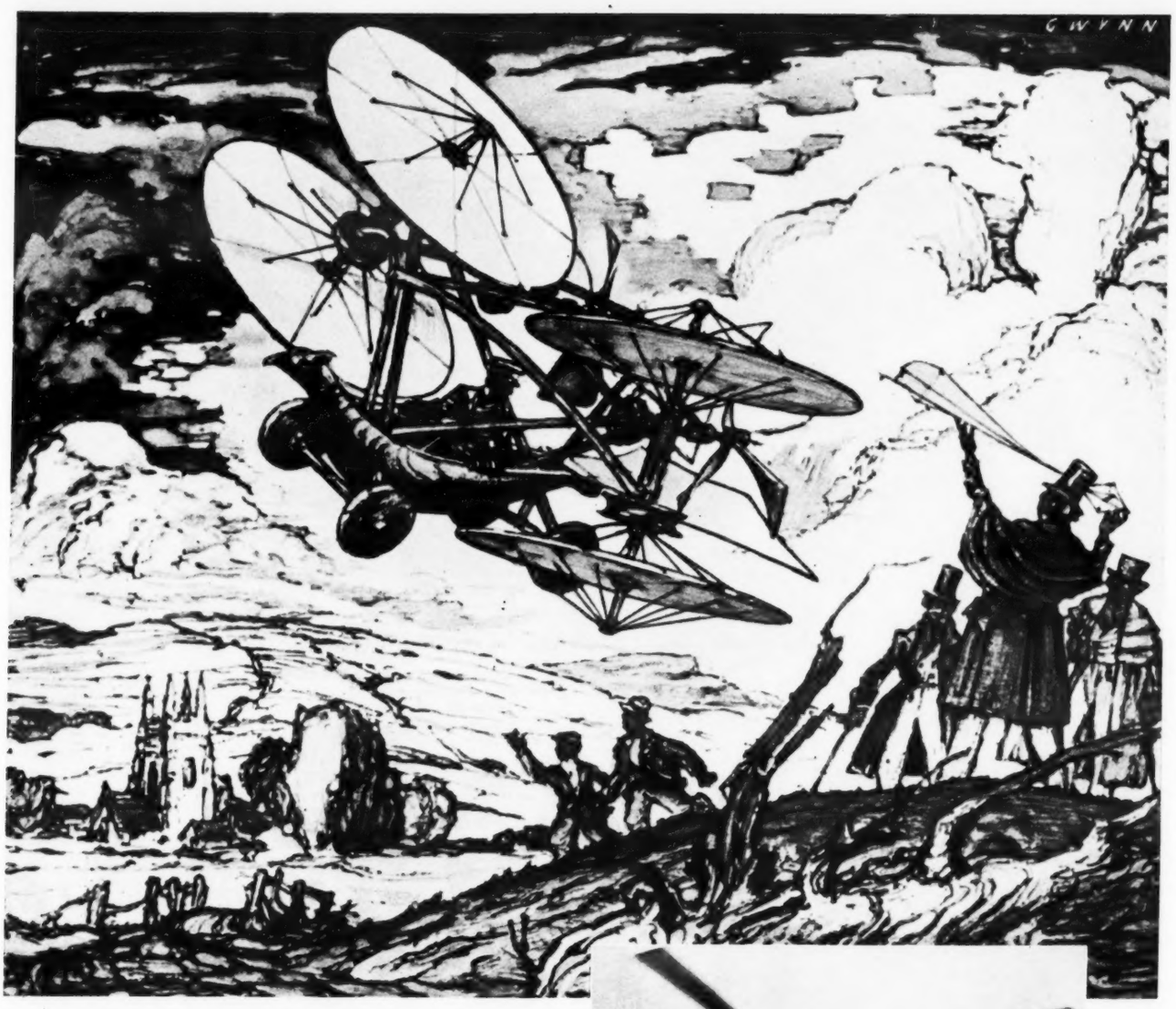
TOLEDO 1, OHIO, U.S.A.
...a member of the growing KAISER INDUSTRIES

the 'Jeep' family—a balanced line of 4-wheel drive vehicles



the world's most useful vehicles

Propulsion through the ages...



A Great Pioneer - Sir George Cayley, 1843.

This dramatic but imaginary scene shows how the fruition of a dream might have appeared. This strange machine was designed for vertical take-off and landing, after which the four rotors were adjusted for forward flight, propulsion being provided by two pusher-propellers. The inventive genius who saw this vision of the future was a Yorkshireman, Sir George Cayley, who also designed internal combustion engines worked by gunpowder—and constructed the model kite-glider seen in the hands of the spectator on the right. Cayley was the first man to realise the aerodynamic potentialities of the kite, and the model here about to soar over the peaceful Wolds was the first successful heavier-than-air craft to be built.

Sir George Cayley was a pioneer; and so too is Rotol; for they designed, developed and produced the propellers for the first turbo-prop aircraft to fly. To-day, over 100 airline and aircraft operators across the world attest to the reliability of Rotol propellers—standard equipment on the Vickers Viscount; Fairchild F. 27; Grumman Gulfstream; Armstrong Whitworth Argosy; the Fairey Rotodyne, and many other aircraft.

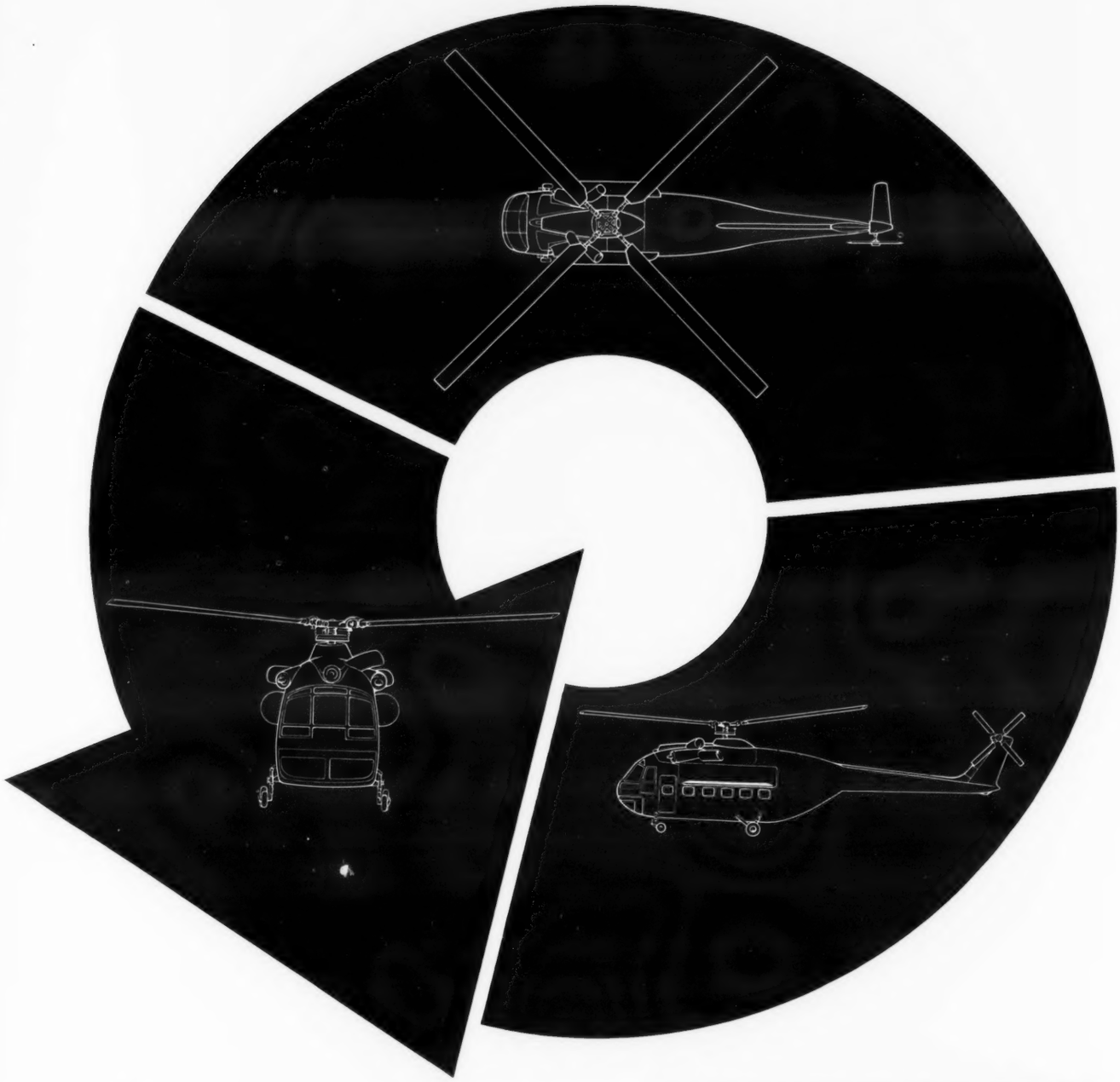
THE FAIREY ROTODYNE

Rotol are proud to have an important share in the development of this revolutionary aircraft—the world's first vertical take-off airliner. The two Napier Eland engines drive two Rotol four-bladed "forward flight" propellers—and Rotol also provide two gear-boxes for each engine ; a constant speed unit, and a throttle governor.

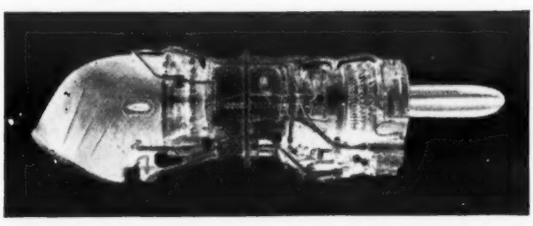
ROTOL

A member of the Dowty Group

ROTOL LIMITED · GLOUCESTER · ENGLAND



Gnome



has been chosen for the **AGUSTA 101G**

multi-seat helicopter

The de Havilland Engine Company Limited, Leavesden, Hertfordshire, England

788

Airlines of the Middle East

Given stability and peace, the Middle East is on the verge of a civil aviation boom which will greatly expand its airfleets, airports and facilities.

Economically the region is making considerable progress, and over £300 million sterling is flowing annually into Arab coffers. With a changing political atmosphere and the added growth in the Far East, Middle East centres such as Beirut have become connecting links between the Eastern and Western parts of the world.

The extension of Arab cities and industrialization has increased the flow of goods, technicians and businessmen to and from the West. In addition, with modern hotels available, the tourist is beginning to look beyond the Riviera to Lebanon and Jordan etc., where he can combine sunshine, bathing, skiing and the like with visits to the Holy Places and dozens of archeological marvels from earliest times.

All this means more airline passengers and freight, and increased competition. Studies indicate that the rate of traffic growth in the area is at present 25 % overall and that it will continue at about 20 % for the next five years. This is far above the average for Europe which has passed through its " boom " traffic period.

There are at present ten airlines in the Arab countries, of which only about four are so far of any real size and international potential. With the tide of Arab nationalism, they all want to expand, and a number wish to push their routes further and further out East and West, with their Governments using strategic positions to get bilaterals approved.

The first signs of a tightening up in bargaining came recently when SAS requested an additional three trips per week for its *Caravelle* services Beirut-Rome. The Lebanese Government granted one trip only.

The problems of finance and new equipment are very thorny, and it is clear that some sort of rationalization must eventually come about, creating larger units with improved resources and borrowing powers. The formation of an all-Arab airline, much discussed in Beirut and Cairo in recent months is, however, a very long way off, although the amalgamations of Misrair and Syrian Airlines into United Arab Airlines, and Arab Airways and Air Jordan Co. Ltd., into Air Jordan are steps in the right direction.

The need for new equipment in the jet age to compete internationally and internally will certainly have the effect of putting some of the smaller companies in an impossible position.

The Lebanon has four major air transport companies, and a licence granted for another but not yet taken up. All Lebanese airlines were hard hit by the disturbances in the country in 1958, but are now getting back into shape again.

Middle East Airlines with its *Viscount* fleet is the most important, flying services to Italy, Germany, Austria, Greece, Turkey, the U.K. and India, as well as around the Middle East itself. Its affiliation with BOAC works well, as does that of its associate Middle East Aircraft Servicing Co.

MEA is faced with the perennial problem of re-equipment and while it appears that finance will be forthcoming, there remains the choice of type. MEA has to decide whether to go straight to jets with the *Comet 4* or whether to purchase *Viscount 810s* as an interim measure and await such later types as the Bristol 205 and the DH.121. A decision must be made in the near future, and it is likely that MEA will postpone pure jet operations until the arrival of these ' second generation ' jets.

Air Liban has European, Middle East, and West African routes and through its affiliation with Air France has been studying the possible purchase of three *Caravelles*. It is now rumoured in Beirut that Air Liban is interested in amalgamating with MEA. This would make a lot of sense, give more bargaining power on routes, and lead to standardization of equipment, but the attitude of BOAC and Air France is not yet known.

Lebanese International Airways was licensed for some time before an arrangement was agreed with SABENA. The company now operates a small fleet of two DC-6s and one Curtiss *Commando* aircraft, but apparently has no plans for re-equipping. Apart from several Middle East routes, LIA operates a service to Milan, Paris and Brussels.

Started from scratch by an extremely enterprising young man, Mr. Abu Haydav, *Trans Mediterranean Airlines* has built up a very profitable freight network to Middle East and European countries, using *Yorks*. These aircraft will be time-expired by 1960, and new equipment must be purchased.

Recently TMA purchased two *Yorks* from MEA and two DC-4s from America. The DC-4s will be hired to MEA for freight work. It seems likely that TMA will purchase more DC-4s and probably DC-6s, and the company has been showing considerable interest in the AW.650 *Argosy* for use in the early 1960s.

The *United Arab Republic* is now in the process of building one airline out of the Egyptian and Syrian companies, and it is shortly to place an order for jet equipment. Depending on the " unfreezing " of sterling balances and possibly even on the barter of cotton, UAA will purchase three *Comets* and take an option on two more. This will definitely speed up re-equipment discussions in other Middle East Board rooms.

The Soviet Union made big efforts to sell Tu-104s to UAA at rock bottom prices, but technical considerations seem to have blocked the deal.

Air Jordan, formed from the assets of two other operators in December 1958, is managed by Transocean Air Lines of America. At present operating to only one country outside the Middle East, Air Jordon has ambitions to become an international operator. Using the increasing tourist attraction of the Holy Land and landing rights as bargaining points, Air Jordan is negotiating for services to the North African coast and to Europe — particularly the Roman Catholic pilgrim countries.

The airline is to order Fokker *Friendships,* the exact number depending upon the routes approved. A sign of the increasing interest which other carriers are taking in Jordan is BOAC's possible return this year to Amman, with *Britannias,* and the replacement of MEA's DC-3s to Jerusalem, by *Viscounts.*

Kuwait Airways has had a somewhat chequered career, being originally associated with BOAC and later with West-Air of Wisconsin. BOAC returned to the scene, and Kuwait Airways now operates internal Middle East services with ex-BWIA *Viscounts.* Any question of expansion or the purchase of new equipment rests on the good offices of the Sheikh of Kuwait, who alone possesses the necessary funds.

In *Iraq* the situation is so confused that no-one knows quite who is in charge or what the future may hold. *Iraqi Airways* has both European and Middle East services using *Viscounts* and *Vikings.* Many of the staff have been relieved of their posts for political reasons, and a general reorganization is apparently in progress.

Russia has offered technical assistance, management facilities and new equipment in the shape of the Tu-104, but it is not known as yet whether these will be taken up by General Kassem. The latest reports reaching the West suggest that Iraq is discussing with India possible cooperation, both technical and commercial, for her airline in order to be associated with a completely neutral country.

Saudi Arabia Airlines has a sizeable fleet which is used internally and on inter-Middle East services. Its management is under TWA who is expected to make any choice of new equipment — a matter which is now under consideration.

Aden Airways, an affiliate of BOAC, runs its seven DC-3s from Bahrein in the North to East Africa in the South and Sudan in the West. It is really on the fringe of the Middle East but has an important role to play. BOAC is studying the possibilities of Avro 748 or DH. 123 type aircraft for its associates, such as Aden Airways, to replace DC-3s.

INTERNATIONAL MEETINGS AND CONFERENCES

July 1st-10th : U.S. National Soaring Competition. Elmira, N.Y.

July 9th-11th : National Air Races 1959 (Championship Class Races and King's Cup) and British Lockheed International Aerobatic Trophy. Baginton, Coventry.

July 10th : Helicopter Association of Great Britain Annual General Meeting, London.

July 11th-12th : Flying Rally organized by the Aero Club of Pescara. Italy.

July 12th : Tiger Cub Display, Sywell aerodrome, Northampton.

July 12th : Vancouver International Air Show. Vancouver Airport, British Columbia.

July 14th-15th : ARINC Airlines Electronic Engineering Committee, Ambassador Hotel, Los Angeles, Calif.

July 15th : ATA Public Affairs Committee, Statler Hilton Hotel, Los Angeles, Calif.

July 16th-17th : Radio Technical Commission for Aeronautics Assembly. Los Angeles, Calif.

July 18th-19th : Flying Rally organized by the Aero Club of Verona, Italy.

July 20th-21st : ARS Propellant Thermodynamics and Handling Conference. Columbus, Ohio.

July 22nd-Aug. 2nd : Italian Gliding Championship, organized by the Aero Club of Italy. Rieti.

July 24th-26th : AIEE Air Transportation Conference, in conjunction with 1959 Summer and Pacific General Meeting. Seattle, Wash.

July 26th : Oregon Centennial Air Circus, Portland, Oregon, Junior Chamber of Commerce. Hillsboro Airport, Hillsboro, Ore.

July 27th-28th : Working Group on Radiation Measurements (CIMO). Oxford, England.

July 28th-30th : Air Cargo Inc.'s Airfreight Cartage Conference, Chicago.

July 30th-31st : Sixth Annual Symposium on Computers and Data Processing, Denver Research Institute. Estes Park, Colo.

August 3rd : Canadian Army will commemorate the first Army Aircraft Trials held at Camp Petawawa 50 years ago with McCurdy and F. W. " Casey " Baldwin flying the Silver Dart and Baddecks I and II.

August 4th-5th : Second Annual Western Regional Meeting, American Astronautical Society. Los Angeles, Calif.

August 4th-9th : Adriatic Parachuting Cup (Jadranski padrobanski kup). Tivat, Jugoslavia.

August 5th-7th : William Frederick Durand Centennial Conference on the problems of hypersonic and space flight. Stanford University, Stanford, Calif.

August 8th-9th : Third Flying Rally, organized by the Aero Club of Central Alsace, Colmar.

August 9th-12th : ASME-AICE Heat Transfer Conference. Storrs, Conn.

August 17th : First National Ultrasonics Symposium, Institute of Radio Engineers Professional Group on Ultrasonics Engineering, Stanford University, Stanford, Calif.

August 18th-21st : 1959 Western Electronic Show and Convention. San Francisco, Calif.

August 23rd-29th : 1959 International Round-Switzerland Flight.

August 24th-26th : ARS Gas Dynamics Symposium : Dynamics of Conducting Fluids. Evanston, Ill.

New York Finance Notes

U.S. Aircraft Industry and Air Transportation, Mid-June 1959

BY SCOTT HERSHEY, NEW YORK

Contrasting pictures were presented in the airline industry and the aircraft manufacturing industry as reflected in the mirror of first quarter purchases and sales of securities by company officials in the business they know best.

The men who make aircraft and missiles apparently look with confidence to the future, as evidenced by the fact that they like the looks of their own securities. While most of the buying on balance in the first quarter occurred in industries enjoying improved earnings, an exception was the aircraft manufacturing industry where earnings reports were anything but good. Despite this, the record showed that officers of companies acquired a total of 112,221 shares against 71,830 sold.

The airlines, on the other hand, presented quite a different situation. In this industry shares purchased by officers amounted to 18,472 while shares sold totaled 73,066. Significant trades included purchases, usually under option, of 4,040 Pan American shares and 6,138 shares of Eastern Air Lines. Important sales included 16,800 shares of American Airlines ; 16,700 shares of Northwest and 8,975 shares of Pan American.

On the aircraft side, officials at North American appeared optimistic, acquiring 37,250 shares via the stock option route. Other large purchases included 15,690 shares of Rohr Aircraft ; 8,600 shares of Temco and 18,300 shares of Lear, Inc. Among the larger sales were 15,600 shares of McDonnell ; 11,211 shares of Bendix, partially offset by 4,200 shares purchased, and 5,300 shares of Ryan Aeronautical. Sentiment within General Dynamics was divided, where 9,000 shares of the corporation were purchased by officers and 9,280 shares were sold.

The professional managers of investment (mutual fund) companies were active in aircraft shares during the quarter. Four managements purchased a total of 10,500 shares of Bendix Aviation and three sold a total of 1,550 shares. Five mutual funds purchased 9,100 shares of General Dynamics and three sold a total of 56,800 shares. The Martin Company was popular with the funds, with 107,800 shares purchased and only 2,000 shares sold. Eight funds purchased 64,300 shares of North American, but five funds sold 103,300 of the same corporation's shares. The number of shares which the investment companies purchased in Boeing, Lockheed and United Aircraft was considerably under the number sold in each case.

Purchases of aircraft issues overall approximated those of the preceding quarter, but selling transactions doubled.

As for the airlines, one fund was noticeably bullish, but the only concentrated transactions were in Pan American with four fund managements disposing of a total of 127,300 shares. Fund purchases in this stock amounted to 13,000 shares. American, which has been a favorite of the mutual fund management, was the center of divided opinion with five purchasers of shares and an equal number of sellers.

If there is one industry that has experienced tremendous growth, it is the aviation industry, especially the airlines, and it would appear that investments made in companies in this field would have turned out well. Here's what happened in recent years in a selected few :

Eastern Air Lines, a consistent moneymaker, had a previous high of 58 in 1955 ; recent price of Eastern was 43. TWA soared to 79 in 1945 ; recent price was 37, Braniff has a previous high of 37 1/2, and the recent quotation was 16. Capital Airlines had a high of 49 3/4 in 1945 and Capital recent price was around 20. National Airlines had a high of 34 7/8 in 1945 and recently was quoted at 25. Northwest had a high of 63 1/2 in 1945 with a recent price of 42.

Both Pan American and KLM Royal Dutch Airlines experienced losses in the first quarter. KLM reported a net loss of $2,163,000 against $1,923,000 in the same 1958 period. Pan American's net loss for the quarter was $2,499,000 compared with a net loss of $3,360,000 in the same quarter a year ago. Pan American reported record gross operating revenues, however, with an increase of 12 percent to $71,758,000 from $64,308,000 the year before. Operating expenses were up to $76,827,000 from $71,715,000 in the like period the year before.

Despite these figures, trans-Atlantic air traffic in the first quarter showed substantial gains in both passengers and freight. Passenger increase was 19.9 percent. Cargo volume was up 30.3 percent and mail 15 percent. Average load factor for the quarter was 55.8, up 2.8 percentage points from last year. Total number of passengers was 190,894, of which 124,480 or almost 65 percent went by economy fare service, with 27 traveling first class and 8 tourist class.

While ocean-crossing by jet has given a fillip of novelty to the first jet-equipment lines, there are a number of other factors which work toward continuing growth in intercontinental travel and hence hopes for increased revenues and reduction of losses. More U. S. corporations are establishing overseas plants, licensees and distributors are promoting foreign trade, and European manufacturers have developed markets in the United States. More people then ever can afford the time and cost of such travel. Some trade economists forecast a doubling of air travel by 1966 over 1956.

In this connection, a recent transportation engineering study by Lockheed says that, when the jet age moves into the supersonic travel era, a 2,000-miles-per-hour air liner will be called for and that such a craft is feasible " possibly by 1965 ". The study envisions this craft as powered by chemically fueled jet engines and economic on ranges of 1,500 to 3,500 miles. Models of such a plane have been tested in wind tunnels, and designs are being shown to both airlines and military authorities.

This comes at a time when United Air Lines has just ordered a further seven Boeing 720 jets at a cost of about $3,400,000 each (excluding spares), and has accepted delivery of the first of a $225,000,000 order for 40 Douglas DC-8 jets. United also has indicated interest in the DC-9 on which Douglas is making preliminary studies. United expects its jet fleet will be complete by 1965, with 120 jet transports compared with the present 184 piston-engined aircraft now operating. W. A. Patterson, United president, estimated the total cost of the jet fleet at a " frightening " $600,000,000, although no new financing will be required for the Boeing 720 purchase.

A principal competitor, American, reported that public acceptance of jet transportation was producing load factors above 90 percent on some routes. American, in April, had a passenger volume of 13 percent above a year ago. By the end of the month, the airline had taken delivery of nine Boeing 707 pure jets and 12 Lockheed *Electra* turboprops, all of which have been paid for. In addition, the company has advanced $51,916,305 to manufacturers to be applied to deliveries of aircraft on order.

WHY

RIDDLE airlines

CHOSE THE ARGOSY

More air freight is carried in the United States than in the rest of the world combined — so it is no wonder that the U.S. operators are more cost-conscious.

That is one of the reasons why Riddle Airlines Inc. have placed a provisional order for the Armstrong Whitworth 650 Argosy.

This major break-through in the dollar market is a tribute to the economics of this new British aircraft — the world's first pressurised turboprop freightercoach.

Mr. George L. Giles, President of Riddle Airlines, comments: " Apart from its lower direct operating cost, the Argosy will benefit the indirect expenses, due to lower handling costs . . . The AW.650 is the first aircraft to be designed and produced with this in view. With minimum reorganisation, the Argosy's quick loading and turn-round will save us at least 20 per cent on handling alone."

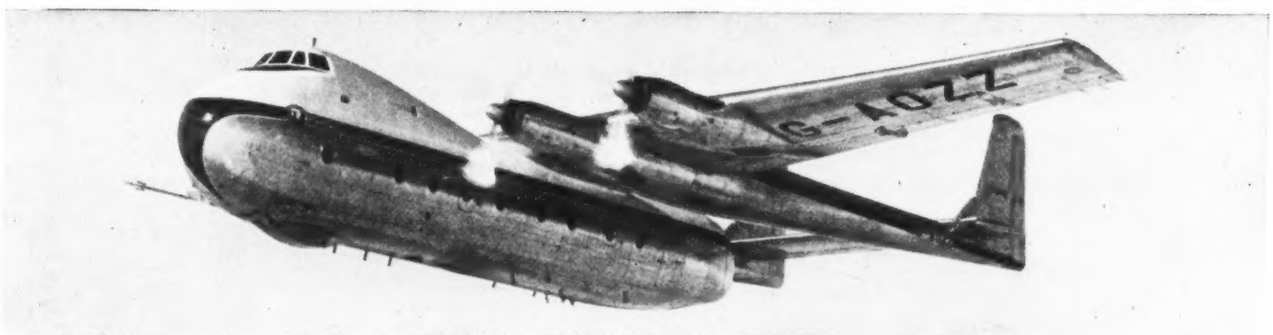
The Armstrong Whitworth Argosy offers cheaper freight rates because :

1. It is 30 per cent cheaper to operate than Riddle's existing twin-engined freighters.
2. The refined loading systems available with the aircraft, together with a full-width freight door at both ends of the fuselage, give rapid turn-round and help to reduce indirect costs to a minimum.
3. The Argosy is extremely simple to service — accessibility has been built in to the design — and it can operate from semi-prepared strips.
4. An extensive service organisation for many of the components — chosen for proven reliability — already exists in most parts of the world.
5. Coast-to-coast operation in the United States is possible within 24 hours, with only one traffic stop or as many as four.

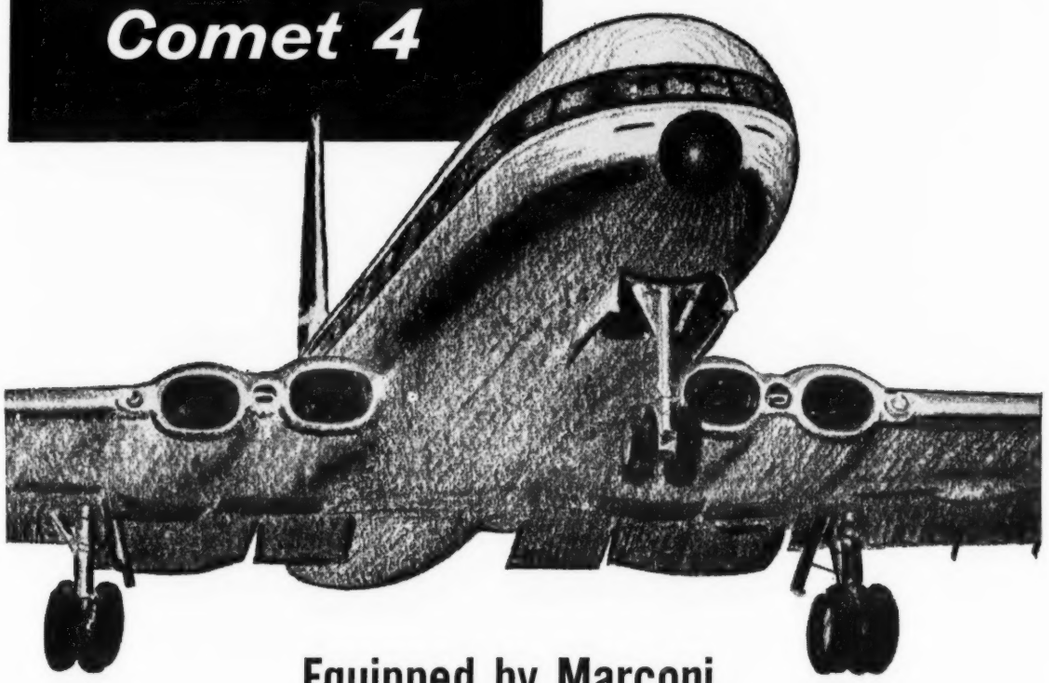
THE ARGOSY BRINGS THE COST OF AIR FREIGHT DOWN TO EARTH

HAWKER SIDDELEY AVIATION LTD

Richmond Road, Kingston-upon-Thames. *International Sales Office*, Duke's Court, St. James's, London, S.W.1.



Marconi in the Comet 4



Equipped by Marconi to meet the major radio requirements of a modern airliner

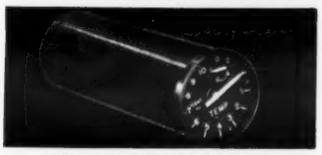
MARCONI

COMPLETE AIRCRAFT AND AIRPORT RADIO SYSTEMS

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ESSEX, ENGLAND

M.2A

Honeywell Thermistor Liquid Level Switch



Honeywell EGTI (Exhaust Gas Temperature Indicator Gage)

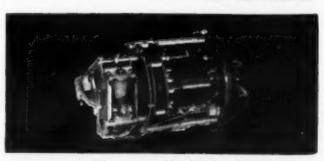
Honeywell Transistor Exhaust Gas Temperature Indicating System

Honeywell Transistorized Fuel Gage

Honeywell Aero's Liquid Oxygen Indicating System

Honeywell Thermal Sensor

Honeywell Integrating Accelerometer



Honeywell Altitude Control

Honeywell Pressure Ratio Indicator

Sales and Service Offices:

HONEYWELL G.m.b.H., AUSTRIA
Vienna
Innsbruck

HONEYWELL S.A., BELGIUM
Brussels
Antwerp
Bruges
Charleroi
Ghent
Liege
Luxembourg

HONEYWELL A/S, DENMARK
Copenhagen
Aarhus

HONEYWELL S.A.R.L., FRANCE
Paris

HONEYWELL G.m.b.H., GERMANY
Frankfurt
Berlin
Düsseldorf
Hamburg
Hanover
München
Stuttgart

HONEYWELL CONTROLS LTD., UNITED KINGDOM
London
Belfast
Birmingham
Cardiff
Glasgow
Leeds
Manchester
Middlesbrough
Sheffield

HONEYWELL N.V., NETHERLANDS
Amsterdam
Hengelo

HONEYWELL A.B., SWEDEN
Stockholm
Falun
Goteborg
Karlstad
Linkoping
Malmo
Skellefteå
Sundsvall

HONEYWELL A.G., SWITZERLAND
Zurich
Geneva
Basel

NEW HONEYWELL AIRCRAFT INSTRUMENTS FOR THE JET AGE

The very nature of a jet engine and the new supersonic speeds and altitudes achieved by jet aircraft have created a need for a complete new group of instruments for the Jet Age. It is natural that Honeywell, a leader in the aeronautical controls field, would meet the challenge to develop and manufacture a line of these new instruments. Some of them are shown on this page:

The tiny *Thermistor Liquid Level Switch* guards fueling operations and operates fuel warning lights.

The *Exhaust Gas Temperature Indicator* measures the exhaust gas temperature within 5° C., safeguards engine life and insures adequate thrust. One-eighth the size, one-quarter the weight, Honeywell's *Transistor* Exhaust Gas Temperature Indicating System will give accurate indication for a minimum of 1000 hours of operation without recalibration.

The completely *Transistorized Fuel Gage* meets the requirement for high accuracy, yet provides the utmost in reliability.

Safeguarding aircraft crews at high altitudes is the job of Honeywell Aero's *Liquid Oxygen Indicating System*. It is accurate to within 2%—and transistorized for reliability.

The Honeywell *Thermal Sensor* converts minute cooling variations into electrical signals. Honeywell has harnessed these signals for use in liquid level sensing systems having response times of from one to four seconds.

This new *Integrating Accelerometer* is a basic component of Honeywell's inertial navigation and guidance systems. Containing an adaptation of the famous HIG gyro principle, the Honeywell accelerometer is a sensing device capable of measuring exceedingly minute accelerations.

Honeywell's *Altitude Control* will hold modern supersonic aircraft to within inches of a selected altitude for extended periods of time.

The *Pressure Ratio Indicator* provides accurate take off power checks and more economical cruise performance for jet engines.

More instruments for the Jet Age are in design at Honeywell—because Honeywell Aero is tuned to the demands of the Jet Age.

Honeywell

Military Products

You've heard about REPUBLIC'S F-105 THUNDERCHIEF

"The world's most powerful one-man airplane," Republic's F-105 Thunderchief is the first aircraft to be shaped by operational fighter-bomber-interceptor experience.

Through more than 1,000 test flights in the United States, the F-105 has proven its immense versatility in any climate, its maneuverability to any attitude.

In firepower it is unprecedented — the F-105 has on a single mission striking power equal to that of all U.S.A.F. aircraft employed in the Korean War. Ready, willing and superbly able, the F-105 Thunderchief, latest in the long line of Thundercraft, is Republic's newest and most potent ally to Europe's own deterrents to aggression.

REPUBLIC AVIATION

FARMINGDALE, NEW YORK, U.S.A.

Designers and Builders of the Incomparable **THUNDER-CRAFT**

FIRESTONE RUBBER-X*

and Shock-Fortified Nylon mean new low costs per multi-engine landing!

Firestone Sky Champion tires help beat the wear and shock of multi-engine landings. They're built with Firestone Rubber-X, the longest wearing rubber ever used in Firestone tires. Compounded exclusively for aircraft tires, Firestone Rubber-X resists the toughest use and abuse for more touchdowns per tire. Exclusive Firestone S/F (Shock-Fortified) Nylon—a new high impact tire cord—gives the tire body unexcelled durability, and enables it to stand up for extra money-saving retreads. With their gripping abilities, flat profile design and S/F Nylon's 40% more fiber stability, Firestone Sky Champions will give you new lows in tire costs per landing.

BETTER LANDINGS 4 WAYS!

1. Flatter profile for more landings per tire
2. Heat-resistant ply construction for maximum durability
3. Firestone Rubber-X for extra toughness and cut-resistance
4. Exclusive S/F (Shock-Fortified) Nylon resists landing impact

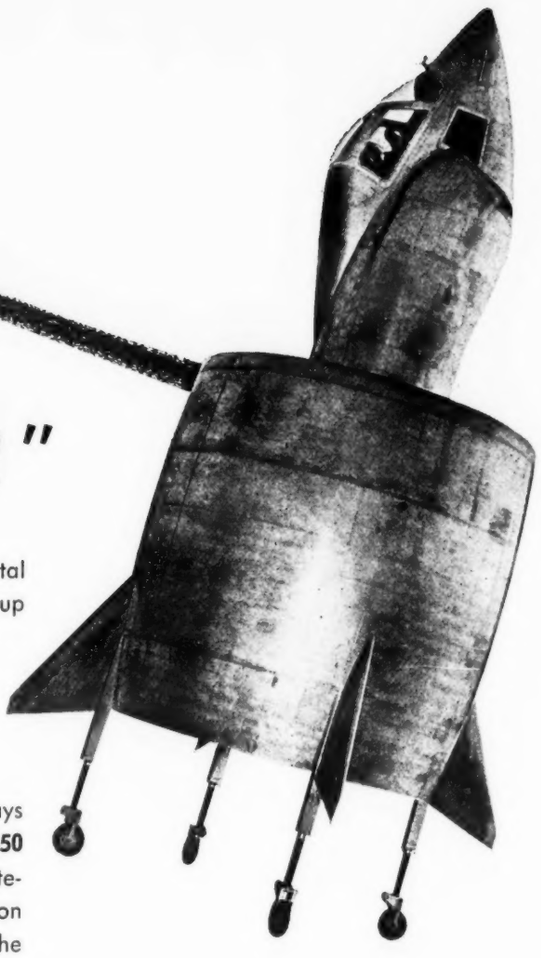
See your Firestone Distributor or write to: Firestone International Co., Akron 17, Ohio, U. S. A. or Firestone Tyre & Rubber Co., Ltd., Brentford, Middlesex, England

*Firestone Rubber-X formulas are specially compounded for aircraft tires.

Firestone SKY CHAMPION

BETTER RUBBER FROM START TO FINISH

THE C 450 "COLEOPTER"



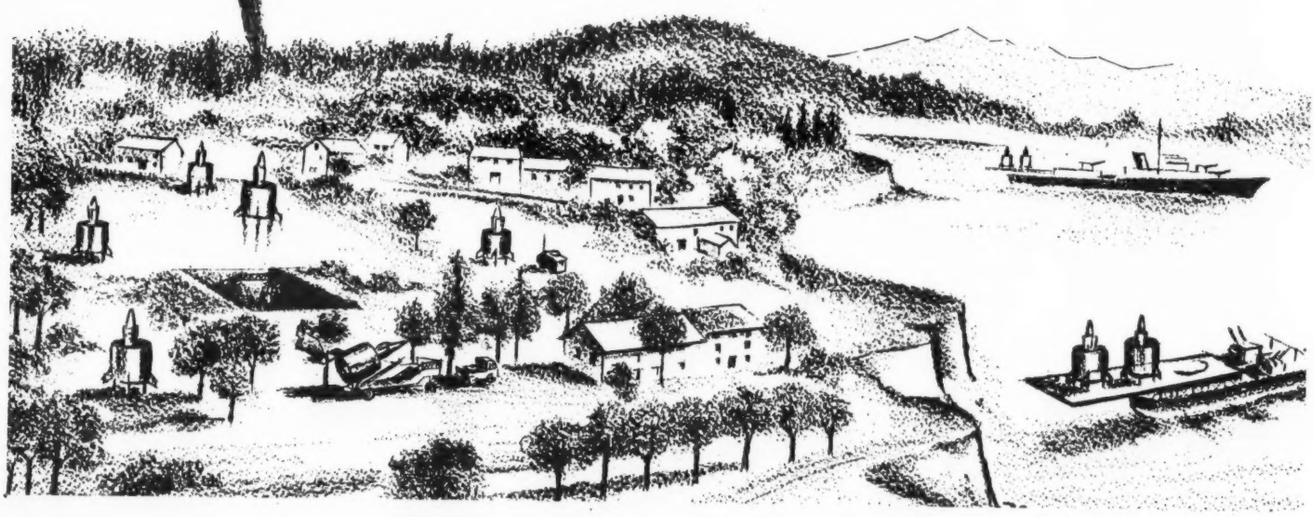
With its revolutionary design, this experimental aircraft, for **vertical take-off and landing,** opens up new prospects for aviation in the following fields :

propulsion,
mechanics of flight,
operational efficiency.

With its ability to operate without runways or costly ground handling equipment, the **C-450 COLEOPTER,** whose technology can be used on remote-controlled aircraft or missiles of all kinds as well as on piloted aircraft, constitutes a vital step forwards in the history of aviation.

SOCIÉTÉ NATIONALE
D'ÉTUDE ET DE CONSTRUCTION
DE MOTEURS D'AVIATION

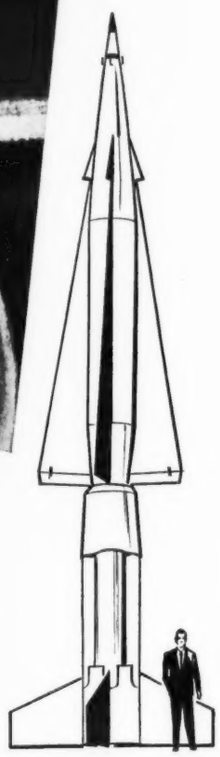
150, BOULEVARD HAUSSMANN - PARIS-VIII



NIKE missile for the defense of NATO countries

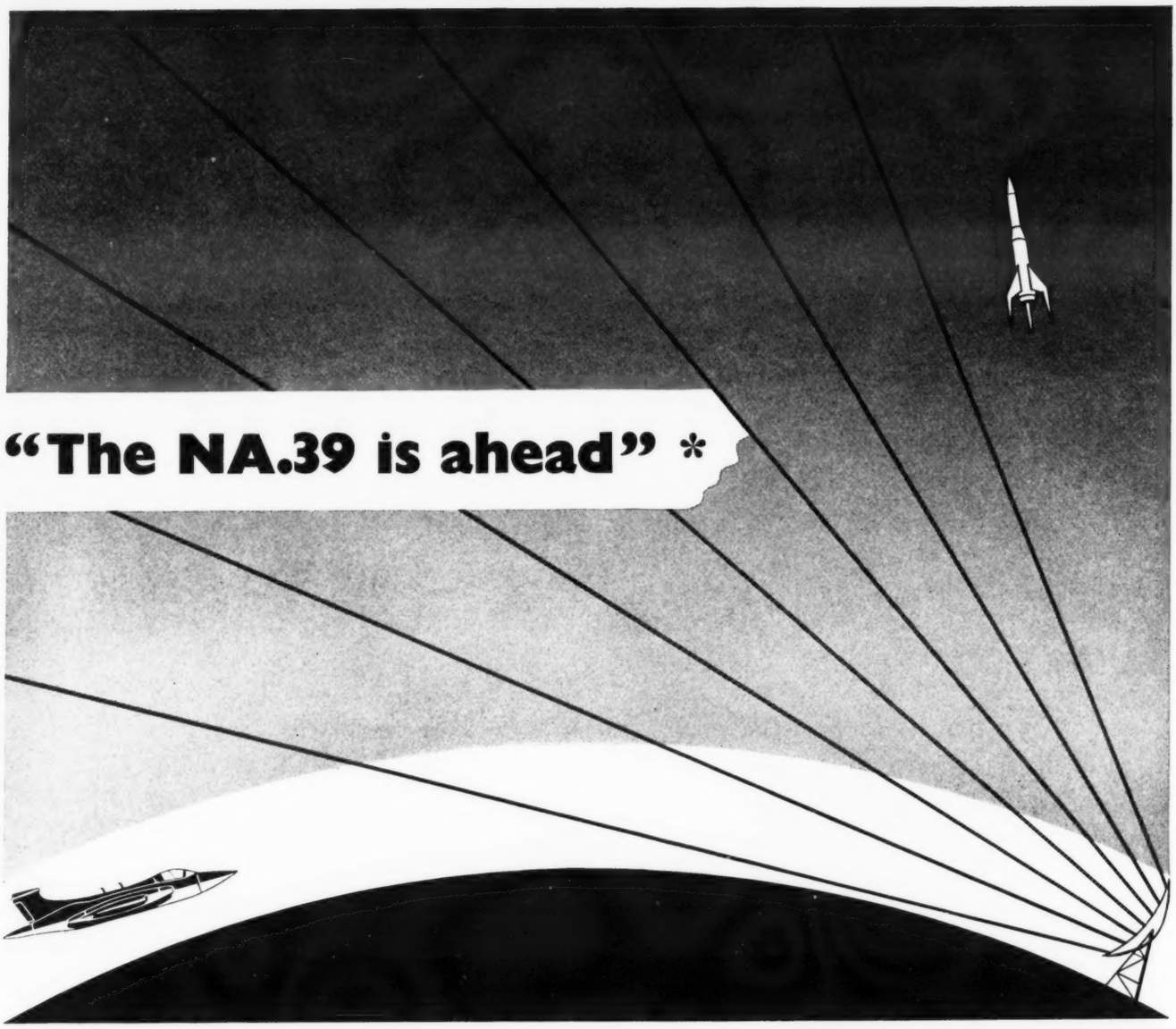
NIKE missiles, product of a U.S. Army-Western Electric-Douglas Aircraft team effort, are already on duty at nearly 50 Army Air Defense installations in the U.S.A. And the sharpshooting *Nike Ajax* and *Hercules* are now available to NATO countries.

Nike reaches far out to destroy attacking aircraft approaching from any direction. *Nike* launchers can be installed at locations around metropolitan centers or strategic targets. But the missiles also can be used as Field Army air defense weapons and for surface-to-surface use. Support equipment is held to a minimum and can be quickly moved to a new site.



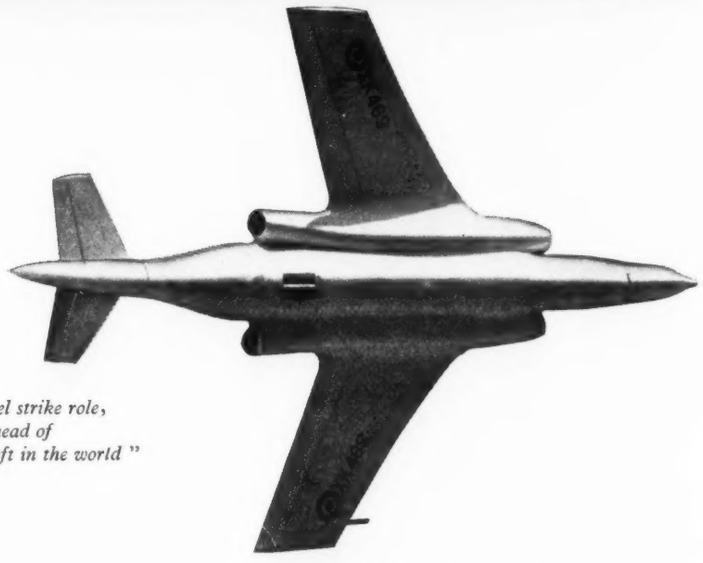
NIKE HERCULES . . .
is the most advanced weapon of the *Nike* missile family now in volume production. In getting *Nike* operational, all procedures of maintenance and training were carefully worked out. Douglas field service men are prepared to help adapt these systems to any defense plan.

Depend on
DOUGLAS
First in Missiles



"The NA.39 is ahead" *

Today, in any major war, an enemy would be protected by an almost impenetrable curtain of radar and guided missiles. But there is a gap *beneath* the curtain; a vulnerable level.
The NA.39 is designed and constructed to strike at this vulnerable level and that is why the Ministry of Defence has stated—



* "*In the low-level strike role, the NA.39 is ahead of any other aircraft in the world*"

Blackburn

BLACKBURN AIRCRAFT LIMITED, BROUGH, YORKSHIRE, ENGLAND

OA135/d

. . . Today, in the era of commercial jet operation, much larger tank capacities are required.

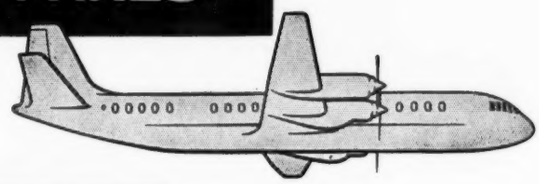
The latest **STRÜVER aircraft refueler** holds

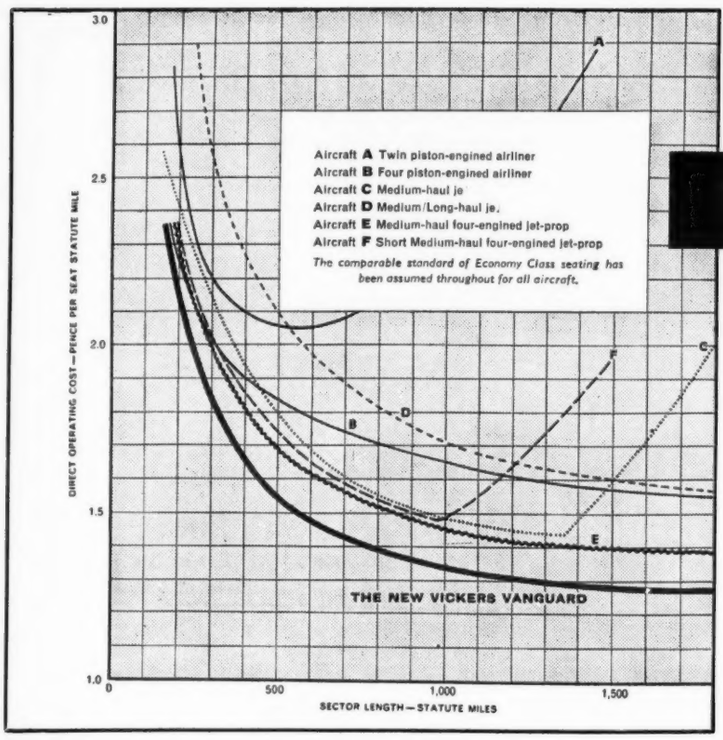
7700 I. G. (9250 US gal.)

Its rate of discharge of 530 I. G./min (635 US gal./min) makes possible rapid and efficient refueling with ground time kept to a minimum. A still bigger **9900 I. G.** (11900 US gal.) unit is at present under construction.

AD. STRÜVER GMBH TANKWAGENBAU HAMBURG

LOWER FARES





yet

MORE PROFIT

The attraction of cheap rate tickets has already been proved on long distance routes. On North Atlantic flights 60% of all passengers now travel at economy fares. A similar cut in fares would be equally popular on short and medium-haul routes, and be the means of boosting traffic considerably. The only aircraft capable of bringing about these reductions, *and* making a profit, is the Vickers Vanguard.
In its economy class layout, the Vanguard has over 50% greater profit potential than any competitive air liner. By a substantial margin its seat-mile costs are the lowest on offer today.

What fare cuts are possible?

At 65% passenger load factor the new Vanguard, in its 139-seater economy layout, can operate at 10% clear net profit with fares ranging from 29-50% below current tourist rates. In calculating these figures actual routes, current fares and current costs have been used.

Only the VANGUARD has all these features

425 m.p.h. cruising · Seat-mile cost as low as one cent per seat-mile · Freight capacity 10 tons at normal densities · Full routing and A.T.C. flexibility · Can use normal existing airfields · Quick turn-round · No airfield noise problems · Quiet, smooth flight · Ten years' unique Vickers/Rolls-Royce jet-prop experience.

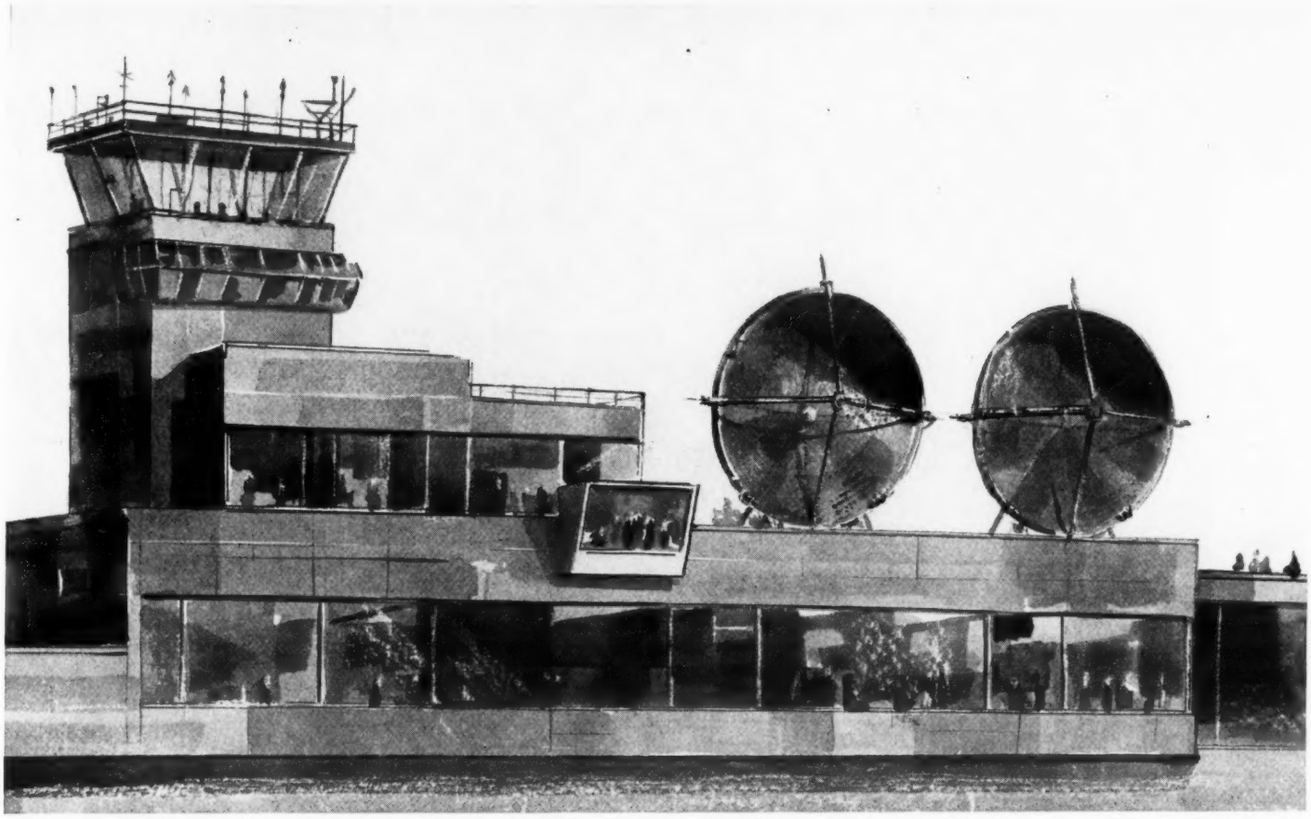
PROFIT with the NEW

VICKERS VANGUARD

FOUR ROLLS-ROYCE TYNE JET-PROP ENGINES

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED WEYBRIDGE SURREY ENGLAND

TGA0A599



REMOTING RADAR DATA with

Canadian Westinghouse Microscatter

Now, Air Traffic Control from remote installations can be relayed *instantly and simultaneously* to points 100 to 200 miles distant!

Receiving signals from search radar, a remote MICROSCATTER unit can relay raw wideband video to airport control towers, command points or operation centres. Identical signals are received at all points at the same time. Data is transmitted *without* conversion into digital form. Communications are made with maximum speed and accuracy. MICROSCATTER also establishes long-distance links *between* control points.

Here are some of the proved-in-service features Westinghouse MICROSCATTER offers you:

- **BROAD BAND TRANSMISSION** of 5 mc. for sending high-quality raw video, azimuth, elevation, control and synchronization data.
- **FREQUENCY BAND** of 4400-5000 mc. will not interfere with radar operation.
- **HIGH RELIABILITY** of up to 99.99% in any weather with quadruple diversity.
- **SPAN** 100 to 200 MILES in a single hop.
- **LOW POWER**—Transmitter output 2 KW.
- **COMPACT EQUIPMENT** is ideal for remote installation. A complete repeater system can be mounted in a 40′ tractor trailer, or units can be delivered by helicopter.
- **LOW COSTS** of antennas (10′ to 28′ diameters), unattended operation, simple installation, low power consumption, easy maintenance all add up to substantial savings with MICROSCATTER radio.

MICROSCATTER APPLICATIONS

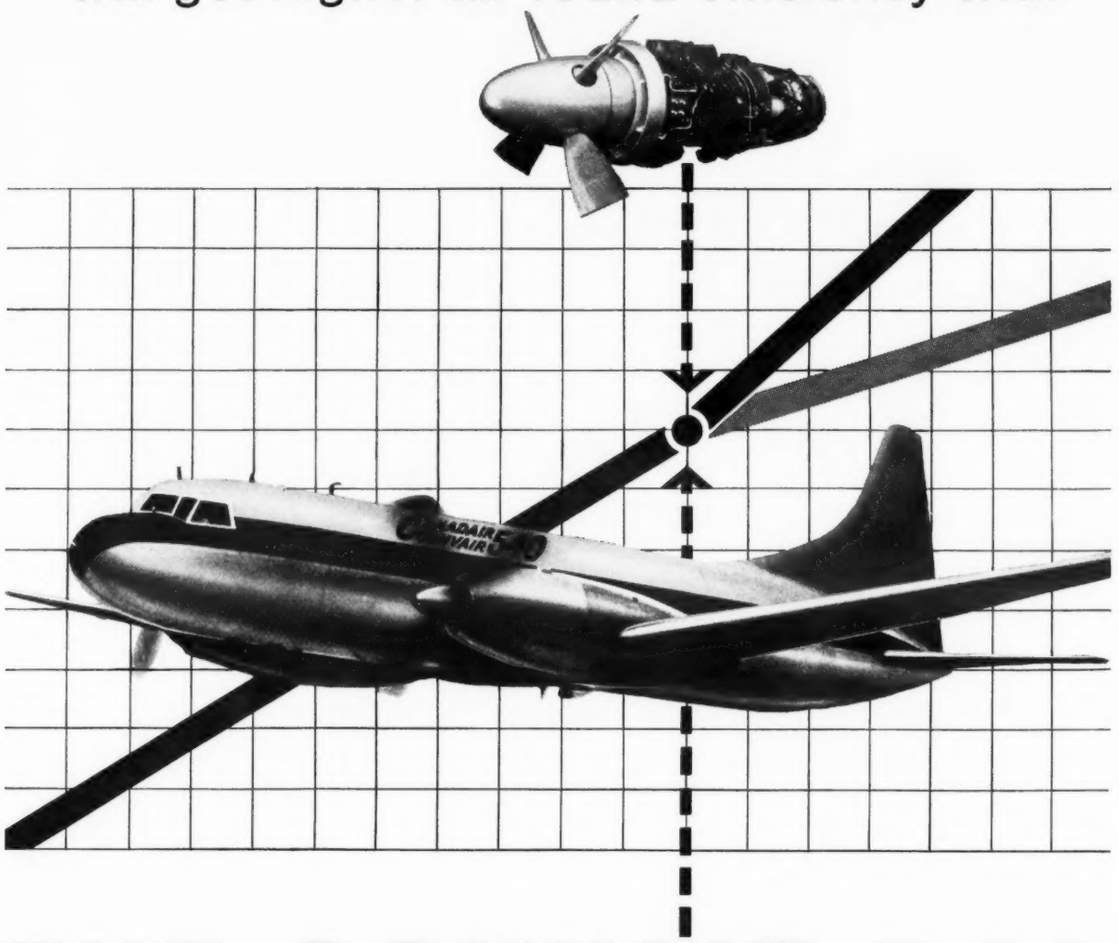
COMMERCIAL	MILITARY
Fixed Station —120 voice channels —television and sound	Wide Band —radar —data —120 telephone channels
Transportable—48 voice channels —teletype	Tactical and Transportable —48 voice channels —teletype —data

For complete information, write to Canadian Westinghouse Company Limited, Electronics Division, Hamilton, Canada.

YOU CAN BE SURE...IF IT'S **Westinghouse**

OPERATORS

will get higher all-round efficiency with



THE CONVAIR 540

Convair 340/440's can now be converted to use Napier Eland engines in a fatigue-free airframe originally designed for jet-props.

The Convair 540 is the conversion equivalent of the **Canadair 540** now in military and civil production.

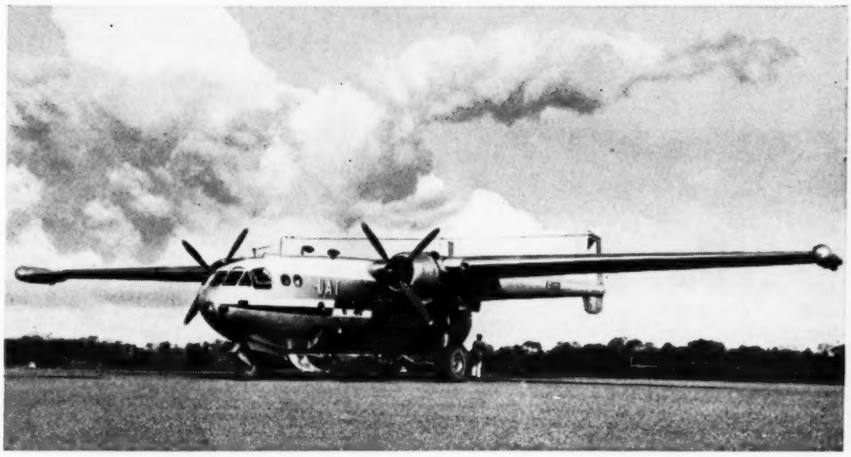
Lower costs · Improved performance · Better passenger appeal

Cheaper and simpler maintenance · Extended service life

THE ELAND HAS
- High aerodynamic efficiency
- Low specific weight
- Low specific fuel consumption
- Single lever control
- Automatic temperature compensation

NAPIER ELAND JET-PROP

D. NAPIER & SON LIMITED, LONDON, W.3. A member of the English Electric Aviation Group



NORATLAS

for the transport of passengers and freight

NORD-AVIATION

Manufacturers of SS.10 & SS.11 anti-tank missiles

CHATILLON-s/s-BAGNEUX (Seine)
2 à 18, RUE BÉRANGER - Tel. ALÉ. 57-40

N.3400

the latest observation aircraft

All over the world, Sikorsky helicopters have carried more cargo than all other helicopters combined.

(and more passengers, too)

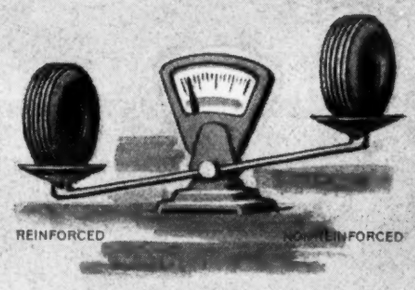
SIKORSKY AIRCRAFT, Stratford, Connecticut, U.S.A.

Sole foreign distributor: United Aircraft Export Corporation, East Hartford, Conn., U.S.A.

European Offices: 3/5 Warwick House Street, London, SW1 England

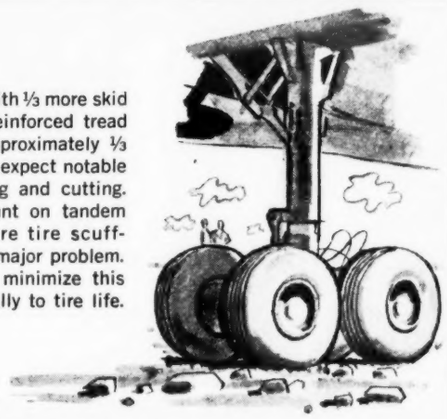
What's the best tread for your new jet tires?

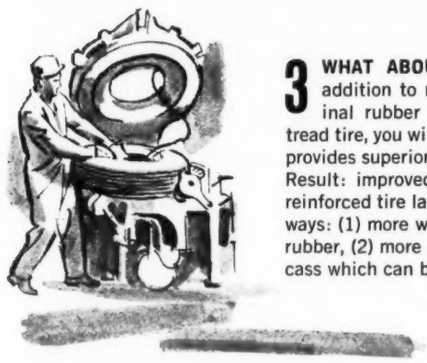
Should you specify reinforced tread or nonreinforced tread for your new Goodyear jet aircraft tires? Here are four questions—and answers—to help you pick the right tread for your plane and pay load.



1 WHAT ABOUT WEIGHT? This must be your first consideration. Reinforced tread tires for jet aircraft offer certain key advantages, but more tread means more weight. Example: a Goodyear 46 x 16 reinforced tread tire will carry eight additional pounds of rubber. Keep this in mind as you evaluate the added benefits which reinforced treads provide. Then—you will be able to balance the weight differential against the savings that reinforced treads make possible.

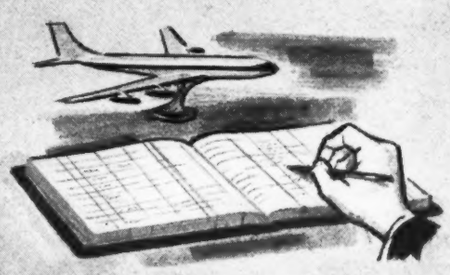
2 WHAT ABOUT WEAR? With ⅓ more skid depth on a Goodyear reinforced tread tire, you can expect approximately ⅓ more landings. You can also expect notable reductions in stone bruising and cutting. This is particularly important on tandem bogie geared aircraft where tire scuffing during sharp turns is a major problem. Reinforced tread tires can minimize this problem—adding substantially to tire life.





3 WHAT ABOUT RETREADABILITY? In addition to more landings on the original rubber of a Goodyear reinforced tread tire, you will find that reinforced tread provides superior protection for the carcass. Result: improved retreadability. Thus, the reinforced tire lasts longer in two important ways: (1) more wear from the original tread rubber, (2) more wear from the original carcass which can be retreaded.

4 WHAT ABOUT SAVINGS? With Goodyear reinforced tread tires giving you approximately ⅓ more landings, tire costs—over the long run—can be reduced by approximately 17 per cent. Consider, too, the savings in man-hours through reduced mounting and changing of tires. Also—greater protection against stone bruising means less chance of "down time" and unscheduled delays. And delays can be costly in terms of reputation as well as time.



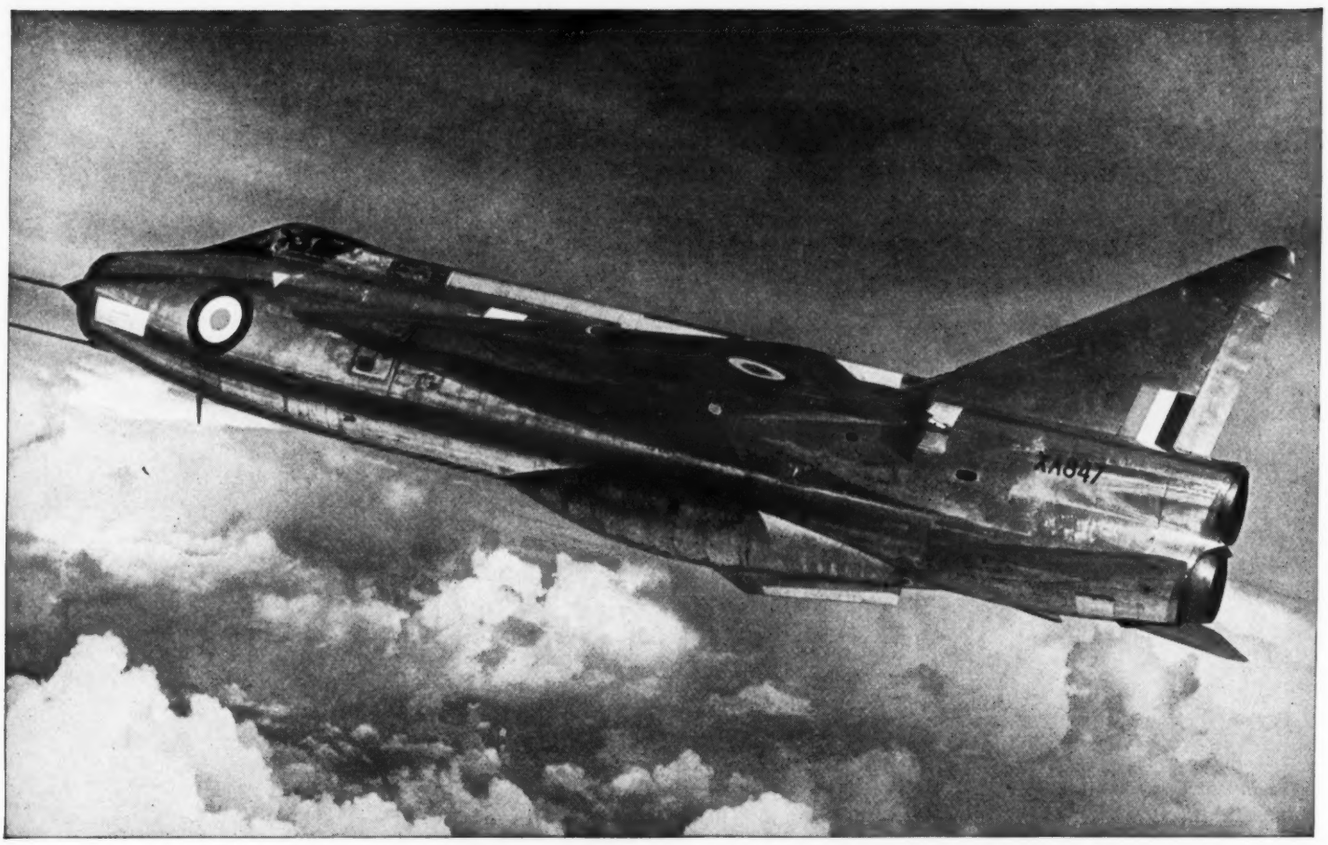
MORE INFORMATION *on reinforced tread tires is yours for the asking. Simply write: Goodyear International Corporation, Aviation Products Division, Akron 16, Ohio, U.S.A.*

AVIATION PRODUCTS BY

GOODYEAR

AS A PIECE OF APPLIED AERODYNAMICS...

Over the whole of its phenomenal speed range—far more than 10 to 1—from its moderate landing speed, through subsonic and transonic speeds, up to its very considerably supersonic maximum, the ENGLISH ELECTRIC LIGHTNING is inherently aerodynamically stable. Without any assistance from electronics it is at all speeds free from pitch-up.



...THE *LIGHTNING*

IS INCOMPARABLE

'ENGLISH ELECTRIC'
aircraft

THE **ENGLISH ELECTRIC** COMPANY LIMITED · MARCONI HOUSE · STRAND · WC2

INTERAVIA

The Intercontinental Missiles Arsenal

Where are the active defences?

The reader of Interavia will not be disappointed . . .

In November 1958 he was given a *survey of tactical missiles,* in which he was told that as early as the end of last year the American arsenal of tactical missiles contained about 25 types which were either operational or ready to go into production. The Western European Powers, on the other hand, lagged somewhat behind, except in the field of anti-tank and anti-aircraft weapons. And the East? No precise information is available and it may be permissible to doubt whether Russia can draw level with the USA in this sector of armaments.

In addition, as discussed in the March 1959 issue, the USA is working towards its long-term aim of developing ballistic missiles shielded from enemy attack, to be fired from mobile platforms or underground launching bases; the question still remains open as to whether these new weapons will wear "Navy or Air Force uniform".

In this issue *Interavia* presents a *survey of operational intercontinental ballistic missiles (ICBMs),* the "big stick" with which it is hoped to prevent global catastrophe, and which, in the view of many generals and statesmen, is the very embodiment of deterrent force, the ultimate check to war.

*

It required fifteen years of study and painstaking development work by American research and industrial organizations to produce the first generation of ICBMs. Without considerable progress in the construction of rocket engines and in the fields of aero-thermodynamics, electronics and precision engineering, it would have been impossible to produce intercontinental missiles with a weight of more than 100 tons capable of carrying nuclear warheads halfway round the globe and placing them on their targets in less than an hour.

This first generation of intercontinental strategic weapons is now in production.

*

If their mere presence were enough to deter, the ideal solution would be found and peace assured for ever. This is the theory which appears to have become an *idée fixe* with many generals and statesmen . . .

There are, however, other concepts, and General L. M. Chassin, whose name is a familiar one in these pages, is one of those critical spirits who refuse to be lulled into complacency by this theory which, however plausible, is by no means without its dangers. He introduces the present issue by remarks which, for all their apparent heresy, cannot be lightly brushed aside. They can be summarized as follows;

- Do not persuade yourselves that there are any weapons which would not be used in an emergency.
- Do not persuade yourselves that passive defence measures alone are enough.
- Above all do not persuade yourselves that reprisal strategy and the deterrent will be completely successful, that everything will go according to your plan, that no one will be the first to push the button . . .

You have created the intercontinental ballistic missile, it is now your duty to create weapons for *active defence.* You may smile sardonically, but if you do not think this can be accomplished you are seriously mistaken. Military history has taught us that there will always be a defensive weapon to counter an offensive weapon, and vice versa. Rouse yourselves, spare neither effort nor expense, and you will achieve the anti-missile missile.

The Prize-Winners in Interavia's 1958 Essay Competition

In June 1958 **Interavia** announced an international competition, with cash prizes totalling $5,000, for essays on a civil and a military subject, namely:

1. Air Travel for All: How can the airlines—in particular the European airlines—make air travel accessible to the broadest sections of the population, without endangering their economic stability?
2. Guided Missiles or Piloted Aircraft? Is the piloted aircraft played out, must it abdicate in favour of the guided missile, or will the two weapons continue to exist side by side for a long time to come?

Altogether 235 essays were received. The rules of the competition laid down that all entries were to be written under a pen-name, and each entry accompanied by a sealed envelope containing the competitor's full name and address. These envelopes were not opened until **after the prize-winning essays had been selected,** so that the identities of the authors remained unknown to the adjudicators.

The adjudicating panels met in Paris on June 18th, 1959, during the 23rd Salon de l'Aéronautique. Two distinct panels had been appointed, one to judge the civil subject and the other the military (see picture). The winning essays having been selected by these panels, the sealed envelopes were opened and the names of the prize-winners announced, in the presence of approaching 70 personalities representing the aircraft industry, civil and military aviation, the press and radio.

The first prize of $1,500 for the civil subject goes to **R. W. Spurgeon,** of Bentleigh, Victoria, Australia, who had chosen the pen-name "Britannicus". The 2nd prize ($1,000) was won by **Raymond Nivet,** Paris, France, of Air France's technical services, code name "Phileas Fogg". Finally a consolation prize of $250 was awarded to **Hedley S. Crabtree,** of London, who wrote under the name of "Fundament".

The adjudication panel for the Interavia International Essay Competition was: Air Commodore W. den Toom, representing H. R. H. Prince Bernhard of the Netherlands; Keith Granville, Deputy General Manager, BOAC; Robert E. Gross, Chairman, Lockheed Aircraft Corp.; General I. A. Aler, President, KLM; Dr. E. E. Heiman, Managing Director, Interavia; Max Hymans, President, Air France; General J. Kammhuber, Inspector of the West German Air Force; Gilbert Périer, President, Sabena; Don Tomás Delgado, President, Iberia; Professor Giuseppe Gabrielli, Managing Director, Fiat Aviazione. More pictures follow in next issue.

For the military subject the 1st prize of $1,500 went to **Ulrich Dörfel,** of Zurich, Switzerland, under the pen-name of "Plato", the 2nd prize of $1,000 to **E. Delmastro and P. Gennari-Curlo,** of Turin, Italy, who wrote a joint essay under the name "Daniel Lorient". Again a consolation prize of $250 was awarded to **James J. Haggerty, Jr.,** of Washington, D. C., pen-name "Tipu Sultan".

The members of the adjudicating panels and the **Interavia** publishers thank all those who took part in the competition. The number of quality essays was so high that the adjudicators had no easy task. They take this opportunity of congratulating the winners both on their own behalf and on that of **Interavia.**

Meanwhile the results of the essay competition have been announced in the international press and on the radio, and the prize cheques have been sent out. Publication of the prize-winning essays will begin in the August issue of **Interavia Review.** The international press is at liberty to print these essays in full or in extract form without charge, provided that proper reference is made to the organizers of the competition. This may perhaps contribute towards the development of aviation and astronautics.

The **Interavia** publishers thank all those who contributed to the success of the competition, which they hope to be able to repeat every two years on the occasion of the Paris Air Show.

Ballistic Missiles

Nuclear Strategy and the Future

By General L. M. Chassin, Paris

General Chassin commanded the French tactical air force in Indochina and later became Coordinator of Air Defense, Allied Forces Central Europe, until his retirement in 1958.

In 1916, a satirical French weekly journal published an issue devoted to the Hundred Years' War. Amongst the cartoons was a drawing by Gus Bofa, one of the best humorists of the day, showing two frockcoated gentlemen having a most serious discussion: "Do you think it means war?" asked the first. The reply was: "Don't worry, the diabolic invention of artillery has made any future war impossible."

Such memories keep coming to mind at the present time. The advent of artillery represented a tremendous increase in military offensive power and, to the critical minds of the day, it must have evoked thoughts about the "balance of terror" and created a fear of mutual Anglo-French extermination. The effect that artillery had is well known; during the second part of the Hundred Years' War, and particularly afterwards, under the reign of Charles VIII, this comparatively new invention played a decisive role; the King of France, who first applied it properly, was rewarded by many victories. The bronze cannon balls caused the almost immediate surrender of the invincible fortresses which were dominating landmarks in the Middle Ages and which were also the main reason for the defensive strategy usually applied at the time. Fuller has said: "The success of artillery was so sensational that it was generally believed that fortifications were useless."

However, its supremacy did not last long. Barely thirteen years after the battle of Ravenna, where artillery helped Gaston de Foix to victory, this same weapon was unsuccessful when used by François I at Pavia in 1525, because earthworks across the battlefield protected the opposing forces. After 1521, successful sieges became more and more rare and defensive action was usually the most profitable. Fortifications were modified on the eternal principles of withdrawal, dispersal and protection so that artillery became as valuable in defence as in attack. Once again, the theory known as "constant tactical factor" applied, as it has ever since there have been conflicts. The pendulum of war has never remained stationary for long, either on defence or attack; for instance, Foch believed that the machine gun would permanently favour the offensive but, on the contrary, the sudden increase of fire-power reduced mobility and, between 1914 and 1918, the armies were entrenched along static fronts.

All situations cannot, of course, be compared, and it is true that history never repeats itself. However, basic laws are doubtless eternal and this can be proved by the difficult task of correctly interpreting events.

One immediate observation is that no new weapon can be decisive in itself if it is possessed by both opponents. The USA had a monopoly of the atomic bomb from 1945 until 1949. She could have reduced her principal adversary, the USSR, to ashes whatever the balance of power may have been in other respects. If he had so desired, President Truman could have forced Stalin to carry out any order he cared to make by threatening the immediate destruction of Moscow and all the main Russian cities. Stalin would have been obliged to obey for the following reasons which, although they may be obvious, must nevertheless be clearly understood if the present situation is to be appreciated.

a) Stalin had neither the atomic bomb nor the means to deliver it, and the USA was thus invulnerable.
b) Stalin had no adequate defence system.
c) As a result, the losses which the bomb could have inflicted on Russia were too heavy to be supported for long.

As soon as Russia herself possessed both the bomb and the means to deliver it, the above arguments applied equally to the USA, and the situation of balance of power and total neutralization applied. It is commonly said that "nuclear weapons have, in such a situation, lost their value in attack, and the threat of reprisals similarly obviates their use in defence. The only importance they retain is to make the adversary fear retaliatory action and it is, in consequence, essential to possess this weapon: but their mere existence is sufficient".[1]

This theory is fundamentally wrong. Throughout history, once a weapon has been available, it has always been used eventually. It would be extraordinary if the laws of war were suddenly reversed. The only reason that nuclear weapons have not yet been used is that there is no adequate defence against them, particularly since the development of long-range ground-to-ground missiles.

To complete the picture, a definition is necessary of the term "adequate defence"; if it is to be adequate, the defence system must:

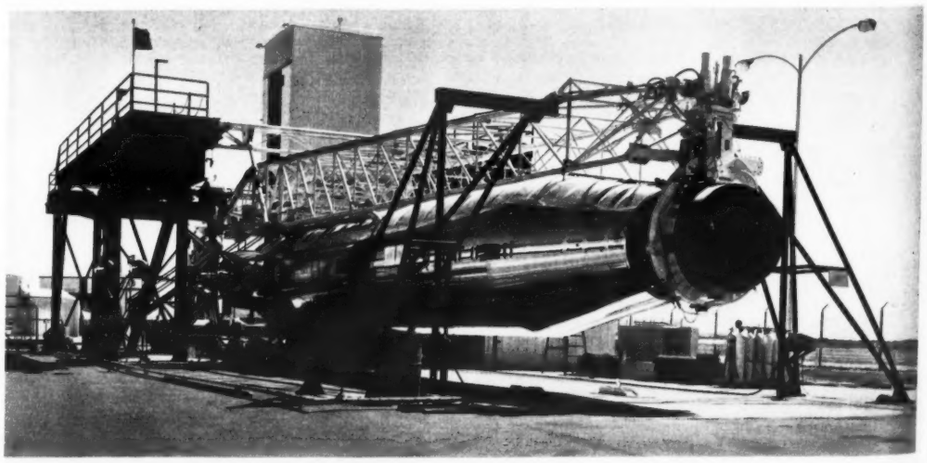
a) Prevent the attacker from inflicting prohibitive losses on the defender;
b) Destroy so many aircraft or missiles that the aggressor cannot maintain the offensive until a decisive result is obtained.

An aggressive and defensive force exists in both cases, and the fatal contest continues until one of the powers has achieved the total destruction of the other without itself being annihilated. This is the process of attrition which occurred when the two air forces were opposed during the last world war.

The case of nuclear missiles is different, because their destruction potential is so enormous. During the 1939-45 war, a defending air force considered itself victorious if it destroyed 10% of the opposing bombers because, firstly, an attacking force could not stand such heavy casualties (Harris dixit), and secondly, because losses inflicted by the remaining 90% of the attacking force were insufficient to bring the defence to its knees. The attack had to be sustained without ever achieving the original goal, this fact being due either to inaccurate bombing or insufficient explosive power, and the result was a second battle between the forces of destruction and reconstruction; the outcome of this final contest hung in the balance until February 1945.

In the present situation, the proportions are at least reversed. Even if the defence could stop 90% of attacking aircraft or missiles carrying nuclear warheads, the 10% which reach the target area should be quite sufficient to inflict prohibitive losses and impose capitulation.

[1] F. O. Miksche. La Faillite de la Stratégie Atomique, Paris 1959.



The American Convair *Atlas* ICBM. Shown here is the new erector-launcher system which is to be installed at Warren AFB, Wyoming. A clamp at the end of the 70-foot erector boom is fitted round the nose of the missile which is then stored in the horizontal position.

The final stage of this analysis is to define the expression "prohibitive losses". A recent estimate showed that an atomic aggression on the USA by bombers attacking 155 large cities of which only 70 had been evacuated, and involving the release on target of 166 atomic or hydrogen bombs of between 10 kt and 20 mt, would kill 8 million people, wound 6.5 million and destroy 6.7 million homes. Forty-one million Americans would suddenly be homeless. Half of the principal towns would be destroyed by fire, the economic and administrative life of the remainder of the country would be completely dislocated, and all resistance would cease forthwith. Such a prospect is so horrifying that the usual conclusions would appear fully justified, particularly when the psychological point of view is considered. In fact, the question arises whether the higher standard of living and comfort enjoyed by the people of the Western powers would not make them more liable to demoralization than the communists, who often have a more miserable and fatalistic existence. This argument is not within the scope of the present subject and, for the purposes of this article, it will be assumed that both parties have the same morale.

It is useful to discuss whether the present theory would still apply if the defence was suddenly improved to such an extent that the losses would be 10% of the figures mentioned above; in other words, the USA would have only 800,000 casualties during the initial attack, and 15 towns would be hit instead of 155. Despite the reduction, the casualties would still be terrible, but it is as well to remember the catastrophic state of the German cities at the beginning of 1945, and particularly the dreadful holocaust at Dresden and the inferno that raged over Hamburg. Some Japanese towns were also subjected to the same treatment after due warning, but both the Germans and the Japanese nevertheless continued to resist for many more months in the hope, especially by the Germans, that their development of new weapons would allow an even more drastic retaliation. An example might be the case of two modern cruisers equipped with similar armament and engaged in a classic naval battle; each vessel could sink the other in a matter of minutes, and perhaps even at the first salvo. The armour of modern vessels has for long been insufficient to prevent fatal damage, and in a battle of this kind the only possible outcome would be the death of both vessels and their crews. Thus, once again the theory of balance of terror might apply and a reasonable supposition would be that naval battles are now unthinkable, but they still occur and victory rests on surprise attack and superior tactics or, from the point of view of defence, on dynamic and static retaliation, superior design and successful evasive action. The loss of an entire fleet with all the crews is, of course, out of all proportion to the casualties which would result from an atomic attack, but the two cases are comparable nevertheless.

A view of the General Electric Company's Shangri La direction finding station at Syracuse, New York, where long-range radar equipment, such as that used for detecting intercontinental missiles, is tested.

However detailed this study may be, it cannot be complete without discussing the maximum percentage of casualties that any nation can support. Some years ago, military pundits quoted a figure of 4% of the population, the losses being incurred over a considerable period, but, if this percentage if applied to the USA which has a population of 175 million, this one country might lose 7 million people. In view of the figures quoted above, a slightly improved defence system would enable the United States to withstand one such attack, but not two; if the figures are multiplied by 10, then 8 aggressions of equal force (an unlikely event) could be beaten off. And once this stage has been reached, exactly the same conditions apply as in a naval battle, so that the obvious and regrettable conclusion must be that atomic war is feasible, and that the strategy of guided missiles is no longer a matter of simple conjecture.

At the present it would seem both fantastic and impracticable to improve defence systems to the extent discussed in the previous paragraph but, if survival becomes of paramount importance, then Governments can take passive action such as dispersal and underground protection. Large centres of population are likely to suffer most from nuclear attack and, in the case of England for example, 80% of the population is grouped in the ten largest towns in the country. This percentage of town dwellers makes the Western powers more vulnerable than countries behind the iron curtain although the latter are now beginning to experience the same difficulty; the urban population of the USSR increased from 30 million in 1927 to 87 million in 1956, and the upward trend continues.

Damage caused by blast, heat or radiation in well-built towns might be much less than the estimates, but the production of progressively higher-powered bombs probably nullifies this possibility. Some philosophers have even advanced the theory that atomic war might become a horrible necessity to counteract overpopulation in the world and an ever increasing birthrate. In this connection, a comparison has been drawn with mass suicide by animals such as squirrels or lemmings, which have been known to assemble and to drown themselves in the sea or in a large river, for no apparent reason, as soon as their number exceeds a certain limit. It is to be hoped that the more intelligent human race will cease uncontrolled propagation without taking the

extreme course of atomic suicide, because it would be wiser to control the sexual instinct rather than to experience a deluge of neutrons. A major dispersal of centres of population would be impossible at the present time, and all that can be done is to plan the mass evacuation of women and children in case of international tension.

Underground protection would be the second best solution, after mass dispersal, if it were not for the questions of comfort and cost. Some countries are, however, planning such shelters and they may well reap the reward of their courage and effort on some future occasion. If and when atomic war occurs, the earth's surface will quickly become most uncomfortable and it will then be necessary to emulate the Germans who, in 1943, moved factories, and even entire cities, underground. The fact remains that mankind will only undertake such a vast operation as a last resort.

Some other solution still has to be found. One possibility is the interceptor missile, of which the *Nike Zeus* is the first prototype in the United States. With such recent developments as MASER (Microwave Amplification by Stimulated Emission of Radiation), the Doppler system, and klystrons or other types of transmission tube, the problem of accurate detection of long-range ballistic missiles will soon be successfully overcome, particularly by the Western powers. The offshore bases in Western Europe, Turkey, Iran, the Phillipines and Japan are equipped to detect and track missiles from the moment of launching; direction finding apparatus and electronic computers can then give the course and trajectory, in a matter of seconds, when the missile has ceased to be guided and has entered the ballistic phase of its journey.

The launching of interceptor missiles is also a question that has been solved, after much investment in time and money, by the use of electronic computers, but there has until recently been another major difficulty, namely that of exploding fissionable material at an altitude high enough to avoid dangerous fall-out. There have been some new developments in this respect, and it appears that information obtained during the *Argus* operation has greatly helped research. A defence system giving anything approaching total protection is not likely to be evolved immediately, but it is feasible, and the human mind will certainly find an antidote to this comparatively new danger; thus, once again, the eternal laws of war will have been respected.

Other methods of defence may well be discovered; for example, long range concentrations of energy by radioelectric transmission has already been achieved in laboratory research. An electronic barrier round a country or continent, forming an imaginary Maginot line at an altitude of 100 km for instance, and against which any missile would automatically explode, is by no means as improbable as it might have seemed ten years ago, and it would be unwise to predict what form a future war might take without considering all the many means of defence that doubtless still have to be discovered.

Whatever the future may bring, atomic warfare is possible without mass suicide, providing that the human race prepares passive methods of defence concurrently with the development of all possible active measures which science places at its disposal. General Fuller, a remarkable prophet, wrote the following in 1946: "Instead of cities being walled in as happened in the Viking age, we can picture whole countries girt about by radar sets, ceaselessly 'listening-in' for the first jazz note of the broadcast of annihilation. In the vicinity of these instruments will be hidden away two tactical organizations of atom charged and propelled rockets—the one offensive and the other defensive. The first will be ranged on every great foreign city in the world, because before war is launched—to declare it would be sheer madness—no single nation will know who among the rest is its true enemy. The second organization will be directed by the radar sets, and as soon as they signal a flight of offensive rockets speeding towards them, the defensive rockets will automatically be released by radar, to speed into the heavens and explode in whatever cubic space in the stratosphere radar decides the enemy's offensive rockets will enter at a calculated time. Then, hundreds of miles above the surface of the earth, noiseless battles will be fought between blast and counterblast. Now and again an invader will get through, when up will go London, Paris or New York in a 40,000 feet high mushroom of smoke and dust, and as nobody will know what is happening above or beyond, or be certain who is fighting whom—let alone what for—the war will go in a kind of bellicose perpetual motion until the last laboratory blows up. Then should any life be left on earth, a conference will undoubtedly be held to decide who was victor and who was vanquished, the latter being forthwith liquidated by the former as war criminals."[2]

Although exaggerated, the mental picture of a god of war run amok that this passage conveys is a terrifying prospect, and it is fortunate that recent events have proved the author wrong in some respects. It will eventually be possible to withstand atomic war, and the strategy of guided missiles will then become a reality rather than a simple calculation of tonnage and launching procedure. The elements of attack, namely surprise, concentration and saturation, and the principles of diversionary action, will all be applied in a conflict which may well take place outside the stratosphere; the American General Homer Boushey said recently that the United States should secure control of the moon as quickly as possible because "he who controls the moon, controls the earth." The subject of space warfare is, however, outside the scope of this article, the object of which has been to refute the false theories which may well lull the western powers into apathetic and dangerous inactivity.

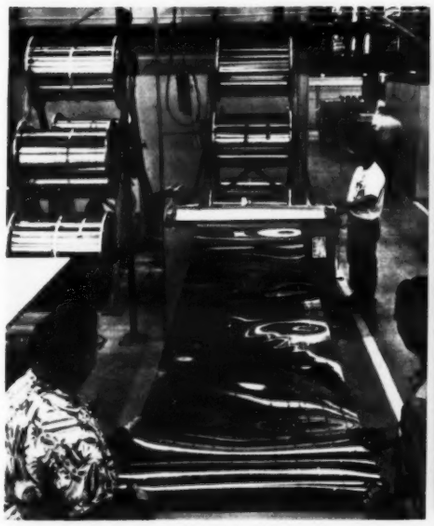
Atomic warfare will be possible again when defence has caught up with attack to such an extent that an overpopulated world can absorb the casualties which such warfare would inflict. Nevertheless, however fast scientific progress may be, it is unlikely that this delicate balance will occur in the forseeable future. Nuclear war now would probably mean annihilation of the white race, and the logical conclusion is that war should be waged in a conventional manner with conventional aircraft, an arm which would then be more important than ever. Governments, engineers and industrialists would perhaps do well to consider yet another more dangerous form of aggression, subversive warfare, which requires the development and organization of a specialized air force.

[2] J. C. Fuller. Armament and History. London. 1946. pp. 194/195.

Manufacturing

The accompanying pictures give an interesting glimpse into the production of the *Atlas* SM-65 intercontinental ballistic missile at the Convair Astronautics plant in San Diego; here the latest *Atlas* models are now being built in quantity and work is in progress on boosters for various space programmes.

Special care is required in the construction of the propellant tanks whose steel walls also form the missile's skin. The steel used in the walls is so thin (0.015—0.040 in.) that the storage space must be kept continually inflated with helium like a semi-rigid airship to prevent its collapsing. When pressurized, however, the unit, weighing barely three tons, is rigid enough to take tens of thousands of pounds of propellant and carry it into space with the warhead at an ever-increasing rate of acceleration (up to almost 6 g). At the first trial launching of the *Atlas* in June 1957, when propulsion was lost at low altitude and more than half the propellants still remained in



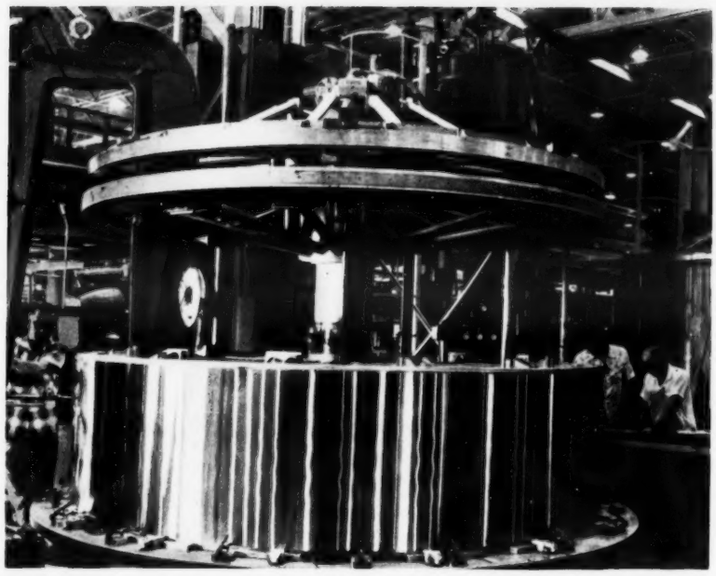
the missile, the extraordinary toughness of the pressurized structure was demonstrated, for although the weapon performed a series of violent gyrations including a loop-the-loop, its body remained intact. It did not break up until the range safety officer gave the order for its destruction.

An important feature of the tank, which is about 60 feet long, is that it has no internal framework. Except for a partition between the liquid oxygen and kerosene tanks, the complete structure from the nose cone to the engine bulkhead is formed by the steel walls of the *Atlas* which, notwithstanding their lightness, have a minimum tensile strength of 200,000 pounds per square inch. The material used is a cold-rolled, easily weldable steel (AISI Grade 301) delivered by the Washington Steel Corporation in rolls consisting of bands approximately three feet wide. The construction of the *Atlas* airframe made it necessary to develop new welding techniques; here Convair drew on the extensive experience of the Solar Aircraft Corporation of San Diego, who, as sub-contractors, built the first thin-skinned *Atlas* tank in the winter of 1953/54. All subsequent airframes have been constructed by Convair.

The construction of the tank begins with the joining of the ends of a steel band more than 30 feet long and about three feet wide in a butt-weld (edge to edge) so

the Atlas at Convair

as to achieve a circular section about 10 feet in diameter. This "drum," reinforced at its inner seam by a parallel strip of stainless steel, forms the first section of the tank. When mated with similar sections by lap-welds (edge over edge), the body of the *Atlas* gradually takes shape out of the steel bands. During welding the tank sections must be stiffened by supporting rings to maintain the desired shape. At the forward end the tank is tapered conically to a domed steel bulkhead. A similar, larger bulkhead near the centre of the tank separates the liquid oxygen chamber above from the kerosene chamber beneath. A conical bulkhead forms the aft section of the tank. The welding of this conical section is the final stage in the operation: it requires the use of a two-armed welding device, one of the arms working on the outside of the seam, the other on the inside. The inner arm is inserted through a 24-inch access hole at the apex of the aft bulkhead.



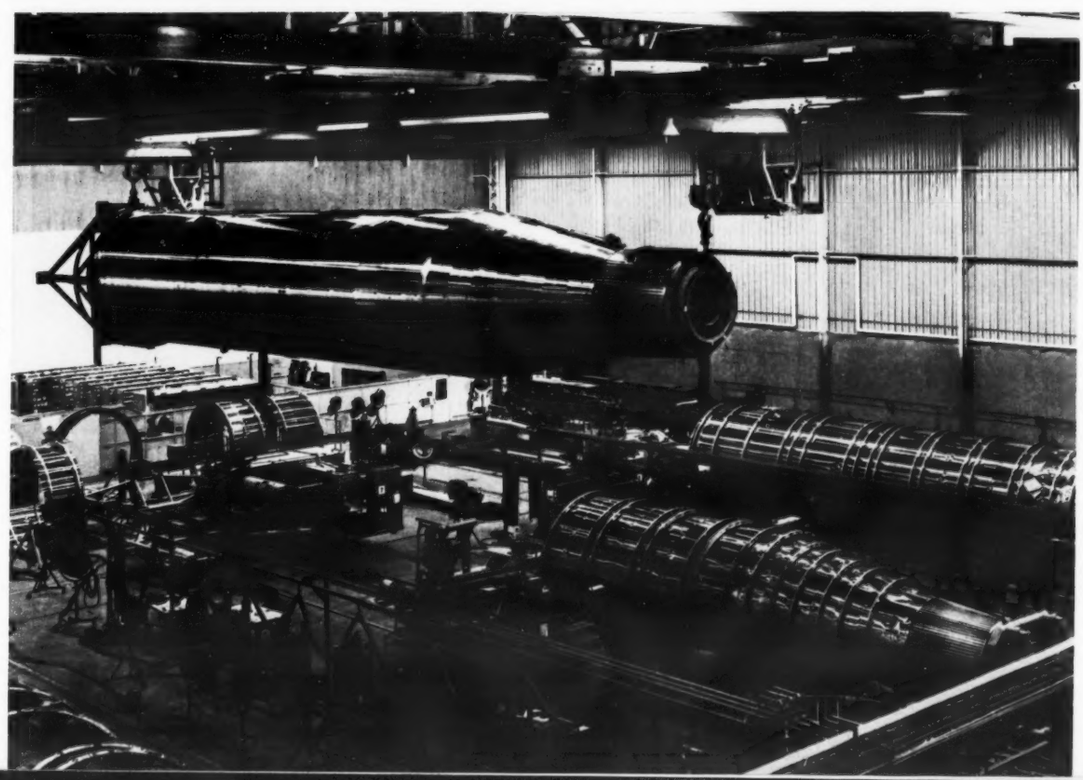
Construction of the combined propellant tank and airframe starts with the joining of the ends of a steel band more than 30 feet long and about three feet wide. This band is stretched over a circular jig and is being butt-welded by an automatic welding machine operated by the man on the left. The seam will be reinforced with a narrow underlay strip of stainless steel.

The final welding process lasts about 16 hours, during which two men, a welder and a mechanic, must remain inside the tank to telephone reports on the progress of the welding to the operators outside. This two-man crew is relieved every two hours, the men entering and leaving the conical bulkhead by the access hole. When the work is finished, the welding arm is removed and the hole in the aft bulkhead is covered with a lid. The entire tank is then pressurized with helium, the wrinkles in its skin at once disappear and the supports can be removed.

After inflation and the fitting of special fixtures to the fore and aft ends, the *Atlas* tank is ready for transport. A pressure inside the tank of less than 10 pounds per square inch is sufficient for handling, transportation and preparation on the launching pad. The missile structure may be depressurized and entered at any time, provided it is placed under longitudinal stress (i.e. stretched) so as to avoid wrinkling and denting.

As important advantage of this "balloon" method of construction is that the airframe can be converted to fulfil other roles with no change in basic design or welding equipment. Thus the standard *Atlas* ICBM can be used as a booster for the *Vega* and *Centaur* space vehicles, for the *Discoverer* satellites and the *Mercury* programme, merely by using a thicker skin gauge for certain areas of the cylindrical shell or adding more circular sections to the cylindrical part to increase the volume of the structure.

▲ The steel, delivered in bands about 3 feet wide, is unrolled and smoothed by running it through rollers (far left). It is then sent to the automatic welding machine, where it is joined to form circular sections (centre). These sections are then joined together in pairs by special welding devices (see right of picture above). During storage and handling the sections are kept in shape by collapsible rings so as to avoid wrinkling and other deformations.

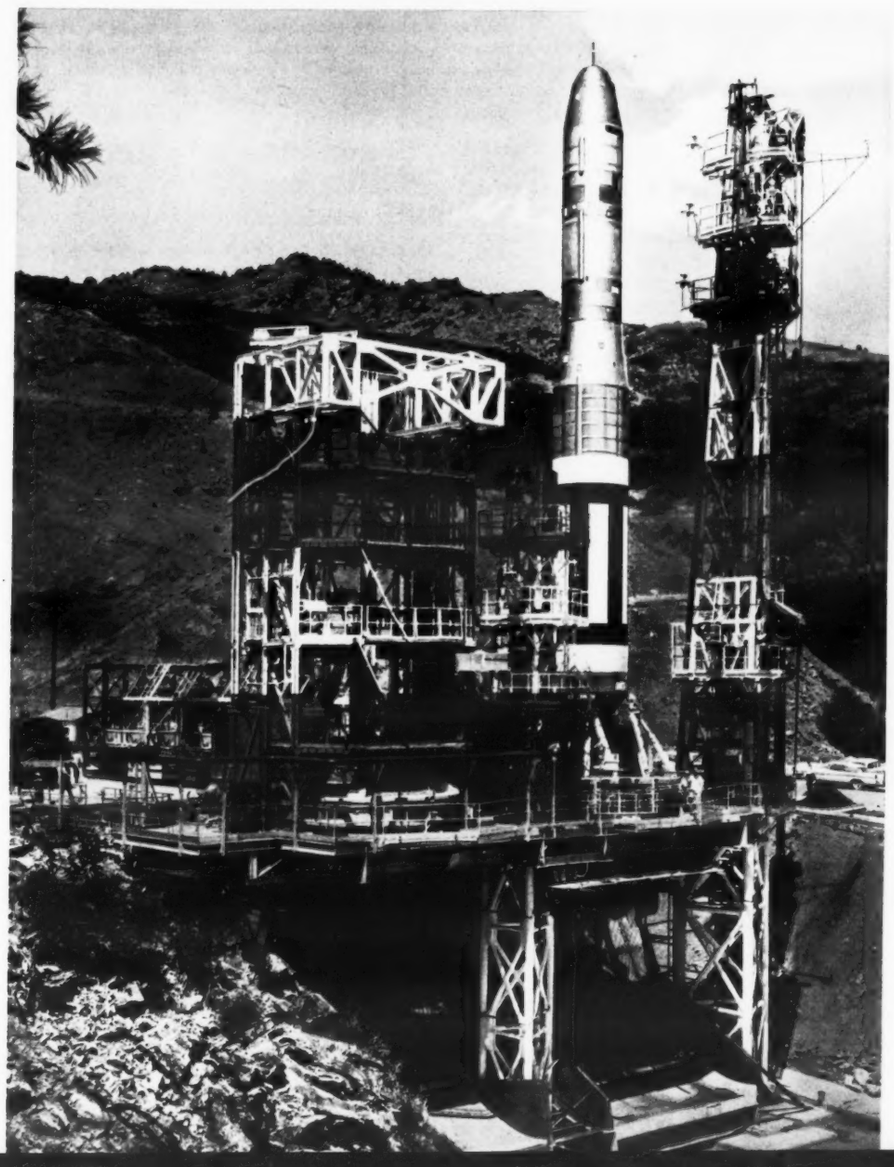


A completed 60-foot helium-pressurized *Atlas* tank being moved by ▶ cranes to the final assembly area for the incorporation of the propulsion section and the control, guidance, telemetry and other systems. On the right, the two tanks under construction are still fitted with their supporting rings. Note the wrinkling on their surfaces, whereas the skin of the pressurized tank suspended from the cranes is quite smooth. In the left foreground can be seen the supporting rings which have been removed from the completed tank and numerous rollers fixed to the workshop floor. The latter enable the missile to be turned about its longitudinal axis during welding.

Development of a Modern ICBM

The office block and one of the workshops of Martin's Denver Division, in the foothills of the Rocky Mountains.

Testing the Titan at Martin's Denver Plant



When the U.S. Air Force laid down the specifications for weapons system WS-107A-2 *Titan* in 1955, it was fully aware that the success of the whole programme (SM-68) would depend on keeping to a strict timetable for the testing of this intercontinental missile. For every larger guided weapon the testing and development phases are at least as important as the basic design, since the behaviour of several hundred thousands of parts during all phases of future missions must be ascertained in detail without the weapon or any of its components actually leaving the ground. And even when the complete rocket is submitted to one of its few, costly test launchings, countless data must be radioed back to the ground over considerable distances, to make good for the absence of human observers aboard the missile.

In view of the pressure of time under which the *Titan* project was placed from the very outset, Martin and the U.S. Air Force decided upon the most extensive test programme which had ever been envisaged for a missile – according to a statement by the Ballistic Missile Division. Above all every component was subjected to searching tests in good time, i.e., before installation in the prototypes, so as to eliminate later delays. All this may seem obvious, but it required a tremendous outlay in test equipment and labour, since the Martin ICBM contains roughly 300,000 parts, which must all function perfectly if the missile is to be reliable in operation. At the earliest

One of the giant *Titan* test stands at the Denver Division site. These double stands enable both rocket stages to be ignited consecutively. The first stage (if required, with dummy second stage attached) is set up on the right-hand platform, and the second stage on the left-hand. Underneath the two platforms are the water-cooled jet deflector plates. A complete *Titan* is seen installed on the right-hand platform; the erector and maintenance gantry have already been lowered.

possible development stage components and sub-assemblies of the various systems were checked not only singly but also in conjunction. Under this practice thousands of parts tests were made and a large number of sub-assembly tests in the laboratory, but only a small number of trial runs of the complete weapon and still fewer free flights from the Atlantic test centre were needed. As every child must be given a name, the programme was soon dubbed "Test Pyramid."

Immediately after receiving a contract to build the *Titan* in October 1955, the Martin Company looked around for a site for a central development and testing ground. The choice fell on a 7,000-acre plot of ground in the foothills of the Rocky Mountains, some 25 miles west of Denver, Colorado, far enough away from inhabited areas to ensure that the local population would not be disturbed by noise or other circumstances attendant upon the strict test programme.

Soon afterwards Aerojet's Covina Division received a substantial contract for the design of test benches and laboratories, and in August 1957, twelve months after beginning construction, the powerplant laboratory was completed. March 1958 saw the first static run on test stand number one.

Martin began testing *Titan* components immediately after the SM-68 programme had been finished. The decision, taken in the initial stages, to manufacture the missile body of aluminium alloy brought the first headaches. The only alloy available with the required strength-to-weight ratio had such a high copper content that it was considered to be unweldable. Yet welding seemed to be essential. As the alloy was so highly suitable in its other properties, however, engineers set to work to find a way of welding it. After months of effort they discovered a new method of welding aluminium alloy, known an heliarc-fusion welding. Further tests at Martin's main plant at Baltimore and by American Machine and Foundry at Dayton, Ohio, led to the present process now used and accepted by the U.S. Air Force.

The integrally stiffened and extruded skin panels for the *Titan* also brought new manufacturing problems. The thick aluminium sheets supplied by *Alcoa* and *Harvey Aluminum* had to be shaped and milled out to the desired contours with integral stiffening ribs. The subsequent acquisition of a two-storey stretch press from the *Hufford Company* simplified this process considerably. The Hufford press takes the biggest skin panels for the 54-foot *Titan* first stage and forms them in such a way that internal metal stresses are greatly reduced.

Despite their light weight, the welded propellant tanks for the *Titan* must be capable of withstanding heavy loads when full feed pressure for RP-1 (kerosene) and liquid oxygen is used. As soon as a tank is fabricated, it is submitted to a series of tests the like of which is not known elsewhere, even for high-pressure steam boilers. It first undergoes pneumatic pressure tests, and then the whole of the wall is X-rayed from the inside for material defects or leaks. The tank is then moved to the eleven-storey Hydrostatic Testing Laboratory, where for the first time it is raised to its natural vertical position. It is then placed in a silo, where it is cleaned and filled with water under pressure. Closed-circuit television cameras in the silo walls photograph any bubbles, folds or other deformities and project a picture of the surface onto a screen in the control room. Leaks are immediately repaired, and tests in the silo are continued until the control engineers are satisfied. The facilities in the Hydrostatic Testing Laboratory are capable of withstanding pressures of up to 5,500 p.s.i.

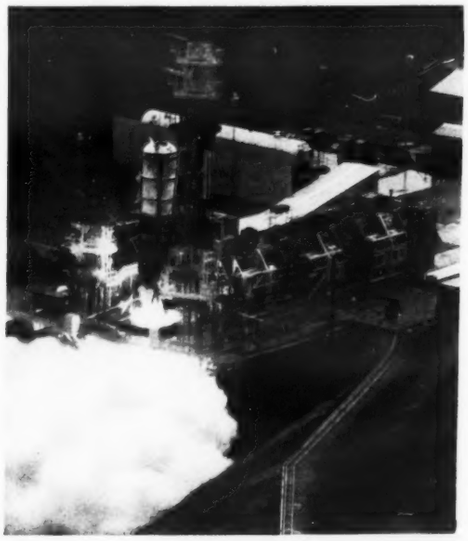
The propellant tank then goes back to the Denver main plant for further tests, while individual parts are checked in the laboratories of the major subcontractors in the *Titan* programme. Beech Aircraft, for example, is responsible for testing high-flow cryogenics, operates each valve in the oxidizer system using either liquid nitrogen or liquid oxygen at −300 °F, simulating the environmental cold, speed, vi-

Firing a *Titan* from the launching pad at Cape Canaveral.

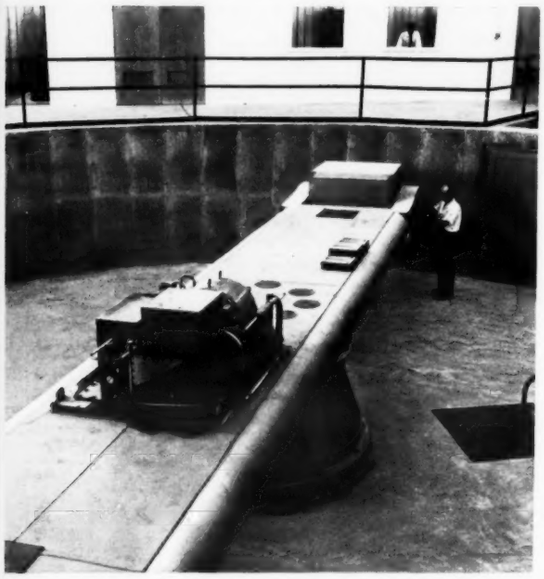
Inside the control room of a static test stand. Right, the consoles for the Master Operations Controller and (above) four television screens.

Large test stand for rockets, similar to the installation shown on the left-hand page. In this picture the erector and maintenance gantries for the first and second stage are in vertical position.

The first-stage rocket engine is test run on the No. 1 stand. Above the engine are the bare kerosene and liquid oxygen tanks.



bration and friction heating. Incidentally, apart from Martin, there are nine other main contractors and 75 major subcontractors, as well as thousands of smaller suppliers, involved in the *Titan* project. A large-scale task for Martin, when one considers that of the total of 500 *Titan* major components something like 185 were developed at the subcontractors' own plants. These products, too, must be sent to Martin's PET (Production Environmental Test) laboratory at Denver before incorporation in the missile. The



One of the laboratory buildings contains this rotary accelerator set in an arena-like well. The twenty-foot base can take test items up to 400 pounds in weight and rotates them so fast that centrifugal forces of up to twenty times their weight occur. During the rotation electric and hydraulic power can be supplied to the test item to operate valves, switches, etc.

PET laboratory comprises test cells for the simulation of multiple environmental conditions (e.g., cold, humidity, dust, low pressure), centrifuges, shake tables, etc.

The wide variety of installations at Denver also includes the propulsion laboratory, where the whole propulsion system—except for the combustion chamber—can be examined in the Cold Flow. With the exception of the rocket engine itself, all powerplant components including the propellant feed system are included in the test circuit.

The *Titan's* rocket engines (an XLR 87-AJ-1 dual engine for the first stage and an XLR 91-AJ-1 for the second) are build by *Aerojet-General* at Sacramento, then officially tested and accepted by the U.S. Air Force on a test stand on the same site, before being sent to Martin's Denver plant for final assembly. In Denver, the engines, together with their accessory systems and complete ground support equipment, are tested anew on a specially erected stand, using compressed gas, RP-1 fuel and liquid nitrogen run through the appropriate circuits. This procedure serves to ascertain that all pumps, valves and controls work together smoothly. Only when these tests have been satisfactorily completed, can the engine components be installed in the production missile.

Technical data for the SM-68 Titan

Although first details of the *Titan* ICBM were published in *Interavia* No. 6, 1959 (page 710), the most important data are repeated below to complete the picture presented in this article.

Overall length	90 ft.
Length of first stage	54 ft.
Diameter of first stage	10 ft.
Length of second stage (including warhead)	37 ft.
Diameter of second stage	8 ft.
Total weight	approx. 220,000 lb.

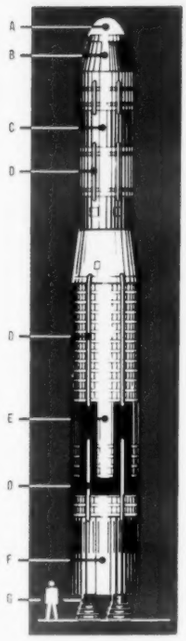
First stage rocket engine

Gimbal mounted Aerojet XLR 87-AJ-1 twin-chamber unit with a total thrust of 300,000 lb.; operates on RP-1 (kerosene) and liquid oxygen.

Second stage rocket engine

Gimbal mounted Aerojet XLR 91-AJ-1 single-chamber unit with a high-altitude thrust of 80,000 lb.; also operates on RP-1 and liquid oxygen.

The first stage carries roughly 70 tons of kerosene and liquid oxygen, and the second stage 20.5 tons of propellant. This takes the warhead (several megatons of explosive power) over distances of more than 6,000 miles.



Key to drawing:

A Avco re-entry body with flat tip and DARAC (Damped Aerodynamic Righting Attitude Control) compressed gas nozzles.

B Inertial guidance system supplied by the A.C. Spark Plug Division of General Motors.

C Integrally stiffened and welded body for the second stage.

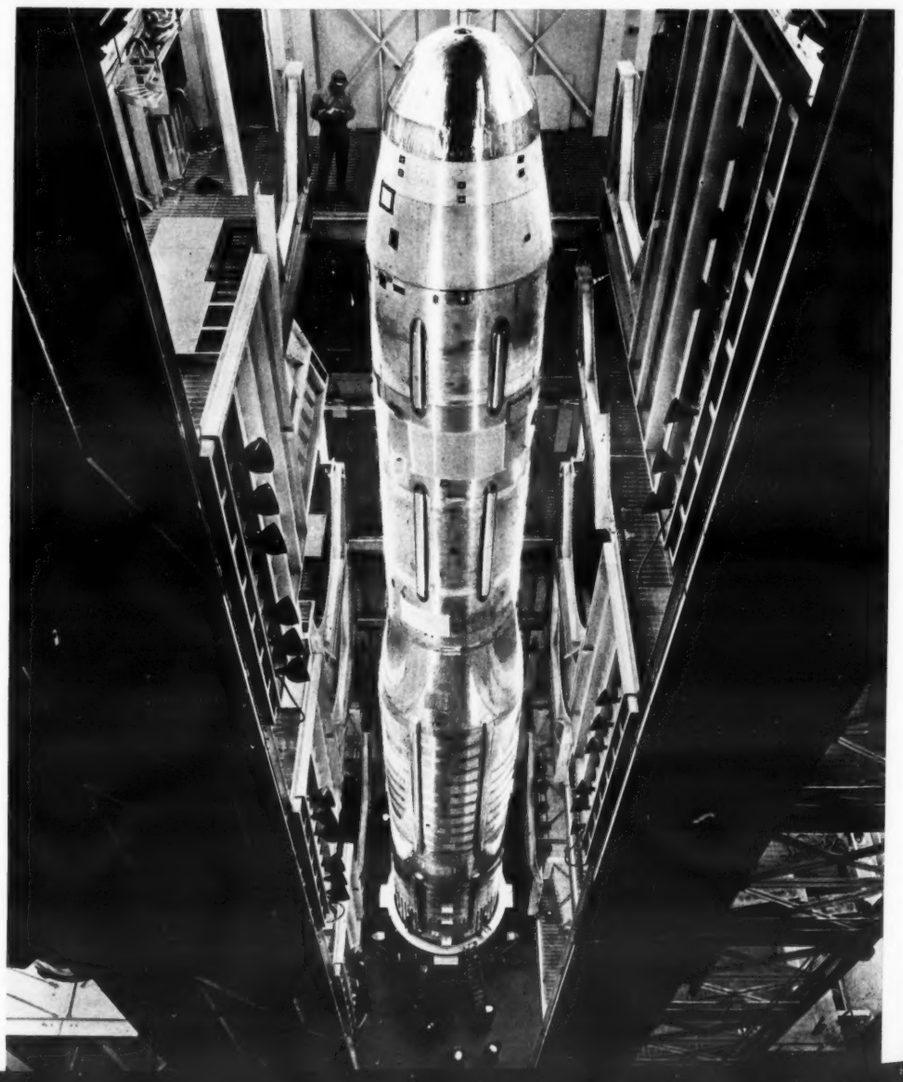
D Stiffeners carrying leads and cables.

E Integrally stiffened body for the first stage.

F Skirt for the engine bay with propellant pumps and gimbal mounting for the two rocket engines.

G Nozzles of the XLR-87 twin-chamber rocket engine.

A *Titan* prototype in the vertical shaft of the VTF test stand. The clamshell gantry closes around the missile.

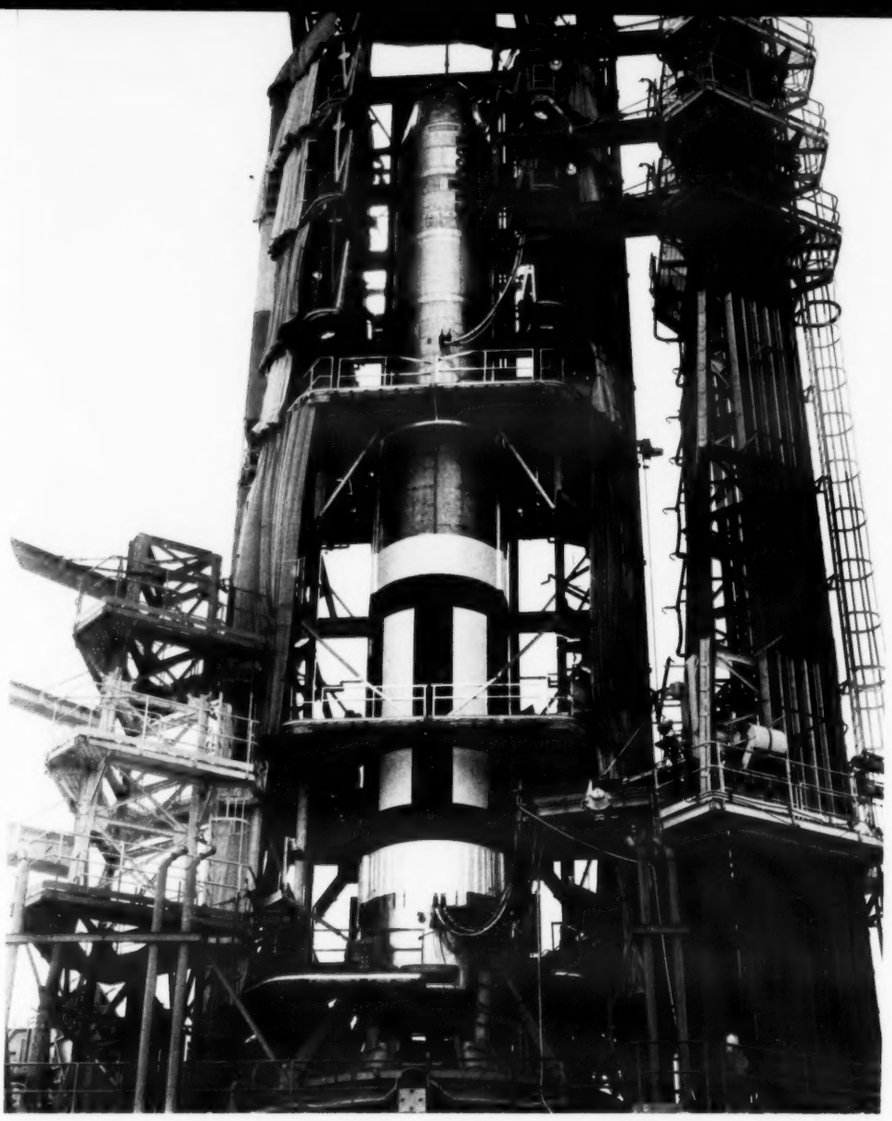


The completed first and second stage of the *Titan* spend the remainder of their existence until launched on what are known as "transtainers" which are fitted with small wheels and are used for handling the two parts of the missile on the ground and during overland transport. The two rocket stages are removed from the transtainers only when they are erected in the huge Vertical Test Fixture for one of the last checks. The 13-storey, 130-foot high VTF contains a number of separate vertical test cells of steel frame construction, each with a dozen platforms one above the other which enclose the complete *Titan* missile and provide access to all systems and instruments inside the missile. Five of these test cells are used for tests within the SM-68 development programme (including two for static tests with simulated side wind effects, vibrations, accelerations, etc., another three for testing the electronic equipment, the ground support equipment, etc.). Four vertical cells are reserved exclusively for yet another systematic check of the missile systems.

The following examples illustrate how realistic the tests in the static cells are. As both these cells are open on one side, the *Titan* ICBM can be suspended from steel booms and swung into any desired position. The rocket body is then covered all over with steel cables which can be tautened by winches in the cell in any desired combination, to represent changing weight, thrust and side wind conditions. During this process the tanks are filled with liquid nitrogen at a temperature of around −300 °F, while a battery of quartz lamps round the missile body illuminates the skin to simulate the tremendous heat produced by friction. In another, closed cell the tanks are filled with water and liquid nitrogen for structural feedback studies. Here electrical and electronic systems are measured for feedback from the structure and its constantly falling liquid level. This test cell is shielded against radio-electronic interference.

The sequence of tests for a production *Titan* is as follows: When the missile has been erected in one of the cells of the Vertical Test Fixture, first all the electrical connections are checked, then the tanks and their propellant feed systems and next the engines and all the other hydraulic and servo systems, including the thrust vector control. Next the guidance system is installed and tuned to the other systems, followed by the telemetry installations (here the missile antenna transmits measuring signals to neighbouring ground receivers). Finally comes a count-down to detect failures, similar to the final check before launching. Countless recordings are made of the missile's behaviour, and the data then reduced to form a detailed "pedigree" of the missile. A team of representatives from the Air Force and the associate contractors makes a final evaluation of the data and decides whether the missile is to be accepted or not.

Yet even now the missile is still not passed finally out of the control of Martin's engineers at Denver. A number of large Captive Test Stands for test runs of the completed missiles have been erected on a nearby hill. These differ from the



A *Titan* ICBM on the launching pad at Cape Canaveral. The missile is accessible from several maintenance platforms and can be protected from wind and rain during launching preparations by means of canvas shrouds. Right, a steel rig with booms to carry electrical cables, pressure hose, fuelling pipes, etc.

The first and second stage of the SM-68 are transported by air by a Douglas C-133 from Lowry AFB, near Denver, to Cape Canaveral.

Precision Guidance System for the Titan

Dr. Charles S. Draper, father of the *Titan* ICBM's inertial guidance system.

The inertial guidance system which is to guide the two-stage Martin *Titan* missile over intercontinental distances to its target with remarkable accuracy was developed some years ago at the Massachusetts Institute of Technology's Instrumentation Laboratory. Details of the lengthy and highly significant development process, however, have only recently been made public. Many weary years passed before A.C. Spark Plug Division of General Motors could be awarded a production contract for the drum-shaped "guidance package" with its gyros and other precision instruments. The MIT engineers and scientists working on the project had first to find the answer to the question of how a missile weighing more than a hundred tons could be guided, without any ground reference or correction data, to a target more than 6,000 miles away, with an accuracy of only a few tenths of a percent of the distance covered.

It was back in January 1954 that MIT scientists began work on an inertial guidance system which was to equip the long-range missiles then planned by the U.S. Air Force. Originally the Instrumentation Laboratory worked under subcontract to the Convair Astronautics Division of General Dynamics Corporation, of San Diego, California, who was seeking a highly accurate radio/inertial guidance system for its *Atlas* ICBM. Later, however, the MIT Laboratory received a direct contract from the Western Development Division of the Air Research and Development Command (now known as the Air Force Ballistic Missile Division), which ultimately led to the creation of the present *Titan* system.

Fundamentally this guidance system is based on studies by Dr. Charles S. Draper, head of the MIT Department of Aeronautics and Astronautics, who turned his attention as early as 1939 to the use of gyros for stabilized platforms and developed the famous Mark XIV gyroscopic gunsight for the Sperry Gyroscope Company. By 1948 MIT was able to demonstrate the first gyro inertial guidance system to the U.S. Air Force. The following years saw the testing of other MIT-developed inertial navigation systems, such as *Spire* and *Spire Junior* for manned aircraft, and SINS (Ships Inertial Navigation System) for submarines and ships.

Finally, the very compact guidance system for the *Titan*, pictured below, took shape. Its most important component is the Hermetic Integrating Gyro to measure trajectory speed. The HIG spins at a rate of 12,000 r.p.m. inside a pressure-tight cylinder which floats in a heavy viscous fluid and pivots on sapphire bearings which are virtually frictionless. Three more gyros are mounted on a "stable package" which maintains a constant position in relation to the fixed stars. This platform also carries three accelerometers which record the accelerations occurring in the three axes in space. Other devices ensure that the system works reliably even during severe roll, pitch or yaw motions. Finally, an airborne computer integrates all data and makes allowance for the earth's rotation from the moment of launching. The computer is supplied by the International Business Machines Corporation.

In order to test the guidance system under realistic operating conditions, the gyro platform was mounted on a giant centrifuge designed for accelerations up to 30 g, on a 140 kW vibration exciter and in an altitude chamber to simulate atmospheric conditions ranging from sea level to 100,000 ft.

The MIT Laboratory at Cambridge, Massachusetts, is also responsible for the inertial guidance system in the *Thor* and *Polaris* IRBMs and a number of recent space vehicle projects on which little or no information is available. Exact details of the *Titan* system are also still on the secret list. All that is known is that the A.C. Spark Plug Division will continue to work in close collaboration with MIT in the testing and advanced development of the *Titan* guidance system.

Four engineers from the Instrumentation Laboratory, Massachusetts Institute of Technology, who have played a major role in the development of the inertial guidance system for the *Titan* ICBM (foreground) are (left to right) Philip N. Bowditch, who supervised the design of mechanical elements for the system, Richard E. Marshall (responsible for assembly), Milton Trageser (calculations of system performance) and Dr. Elmer Frey, Deputy Associate Director of the Laboratory and project engineer for the guidance system.

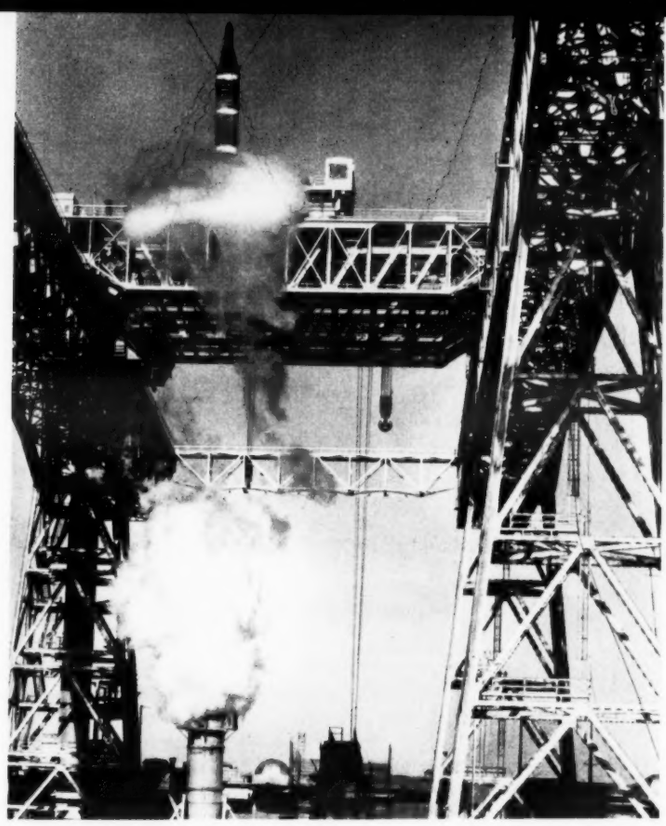
operational launching pads in one detail only; they have no explosive bolts to release the missile on ignition of the first stage engine. The *Titan* remains fixed to the test stand's lower platform. These captive test stands are used for the acceptance runs with rocket engines burning (Missile Compatibility Firing), using operational-type ground support equipment, and remote controlled from a nearby blockhouse. The test stand itself is equipped with a *Baldwin-Lima-Hamilton* six-component thrust mount. The plate used to deflect the exhaust gases is cooled by water flowing at a rate of 19,000 gallons per minute. Inside the blockhouse, which is crammed with oscillographs, television screens, switches and instruments, a controller must now check the missile's "brain", the programmer installed in the second rocket stage. In an operational launching this brain tells the control system what trajectory must be maintained and when the engines must be cut off. It decides when the nuclear warhead must be separated from the second stage and is vital to the success or failure of the WS-107A-2 weapons system.

The Missile Compatibility Firing stands are also used for training the first *Titan* crews and testing improved versions of the Martin ICBM. After test, however, the standard missiles are returned to their transtainers and moved by road to Lowry AFB some 15 miles away (outside Denver), where they are taken by Douglas C-133 turboprop transports to Cape Canaveral or await further assignments. Not far from Lowry the first underground operational launching site for the *Titan* is now under construction.

Strategic Air Command is waiting urgently for the *Titan*. As the entire *Titan* programme is about one year behind the *Atlas* project, the first operational weapons cannot be expected to become available before mid-1960. The nose cone, supplied by Avco, is already at the production stage, as is apparently the guidance system. The Martin Company, as main contractor, is therefore doing everything in its power to ensure that the SM-68 will be ready at the earliest possible moment. The development and test programme described here has done much to speed up the whole timetable. When for example, a small functional error, not hitherto detected, occurred on the launching pad at Cape Canaveral on February 3rd, 1959, the Denver plant was immediately notified by telephone. By noon the next day the identical test situation had been set up on the test stand there, and an attempt made to fire the engines. Here too the system in question failed. By the evening the answer had been found, and Cape Canaveral notified of the result. Forty-eight hours later, on February 16th, the *Titan* was launched on its successful first flight.

The latest *Titan* firings suggest that within the near future the U.S. Air Force will have an extremely long-range weapon of high transport capacity, which is already credited with exceptional accuracy. From the strategic point of view a particularly significant factor is that the WS-107A-2 weapons system has been designed from the outset for operation from underground launching sites.

Operation SKYCATCH



Early in 1959 the San Francisco Naval Shipyard was the scene of an unusual series of tests which carried the *Polaris* submarine-launched IRBM another step towards operational status. Working in collaboration with U.S. Navy specialists, Westinghouse and Lockheed engineers checked all phases of catapult launching with a dummy missile structurally identical with the live weapon, using the following method. The missile was ejected from the launching tube developed by Westinghouse and at the top of its roughly 300 ft. trajectory was caught by an arrester cable suspended from an overhead crane assembly on the wharf. After each launching the missile was gently lowered to the ground again by means of the cable, and the measuring instruments were recovered from inside the dummy.

In earlier over-water launching tests, which were designed primarily to check the launching tube, the *Polaris* dummy was fired out into the harbour or into San Francisco Bay and later fished out of the water. This system, however, made it impossible to carry sensitive instruments, as they would have been damaged on impact with the water. The new method—developed mainly to test the *Polaris* body at high launching accelerations—not only avoids severe "landing shocks" but also offers the following advantages: As the travel distance of the missile is limited, the measuring instruments aboard the *Polaris* dummy can remain connected to a measuring centre via long electrical cables throughout the launching process. Furthermore the heavy dummy can be re-used after each test, since the recovery process by means of cables causes no damage of any kind. The whole arrester system resembles to a large extent the installations used aboard aircraft carriers to brake aircraft landing on deck.

Avco Nose Cone for Minuteman

On April 8th, 1959 the first ICBM nose cone was successfully recovered practically undamaged from the South Atlantic after a 5,500 nautical mile flight through space. It has thus been proved that nuclear warheads can re-enter the atmosphere and reach their targets even after covering intercontinental distances at speeds of around 15,000 m.p.h.

The accompanying picture suggests that the nose cone fired by a *Thor-Able* rocket on April 8th was a forerunner of the nose for the *Minuteman* solid-propellant ICBM. The cone used for the trial bore the designation ICBM Test Vehicle RVX 1-5 and was supplied by Avco. The latter company is primarily responsible for development of the undisclosed type of heat resistant material which withstands temperatures of more than 6,500 °C. This material was melted away by the re-entry heat only at the tip of the vehicle, which retained its original shape. Standing behind the vehicle are (left to right) Colonel John Dodge, Ballistic Missile Division director of re-entry vehicle development, Dr. Jack A. Kyger, director of missile technology for Avco Research and Advanced Development Division, and Lieutenant General Bernard A. Schriever, Commander of the Air Research and Development Command. To the right of the group is a 300-lb. meteorite found in Arizona; its entry into the earth's atmosphere had transformed it into a shapeless mass of iron and stone.

Development Problems of Rocket Engines for Ballistic Missiles

By Thomas F. Dixon, Chief Engineer, Rocketdyne, a division of North American Aviation, Inc.

The author, born at Nashville, Tennessee, in 1916, obtained a B. S. degree in engineering from Vanderbilt University in 1938, continued his studies at the University of Michigan and graduated as an M. S. in chemical engineering in 1940. After further training at the California Institute of Technology, he joined North American Aviation as a thermodynamics engineer in 1946, and the following year was assigned to the Aerophysics Department on propulsion engineering work in connection with the long-range guided missile programme. He was appointed Director of the Propulsion Center's engineering department in 1954, which was taken over by the new Rocketdyne Division in 1955.

In 1957 Dixon received the Robert H. Goddard Memorial Award for his outstanding contributions to liquid rocket development. Editors

The *Atlas, Thor, Jupiter,* and *Redstone* ballistic missiles are powered by liquid-propellant rocket engines developed by Rocketdyne. These engines are charged with the task of lifting the missiles to the correct altitude, guiding them in exactly the right direction and providing the exact speed at the moment power is cut. What makes the successful accomplishment of this task and the faithful fulfillment of delivery schedules in each program remarkable is this: It was only thirteen years ago that we fired our first rocket engine, a 3,000-lb. thrust model motor, on a parking lot next to one of the company's plants in east Los Angeles. And it was only nine years ago, in February of 1950, that we had our first "hot firing" of a big engine at the Rocketdyne Propulsion Field Laboratory in the Santa Susana Mountains. It was back in 1946 that North American Aviation was called on by the Air Force for the design and development of a propulsion system of greater performance than anything ever before conceived. We stepped off into a wilderness, attacking a host of problems posed by the magnitude of the rocket engine booster that would be used for launching of the *Navaho* intercontinental missile. In the years of effort that followed we encountered every possible problem concerned with large liquid propellant rocket engines. The result can be summed up happily in this statement: We have never caused a flight test to be delayed because of a late engine or parts delivery. There were times when we were quite sure we faced disaster, yet every difficulty was surmounted.

The *Navaho* sired an entire family of engines at Rocketdyne. One of them was the 78,000-lb. thrust engine used in the Army's *Redstone* missile. Today the *Redstone* engine is bathed in glory because of its role in lifting aloft the first American satellite. Yet there was a time, nine years ago, when that glory had more of the burning intensity of brimstone and hell fire.

Recalling our early problems with the 78,000-lb. *Redstone,* it is possible to obtain almost a wry humor from some of the situations in which we found ourselves. I remember distinctly a time when we were deeply concerned with the problem of detonations within the *Redstone* thrust chamber. Small holes allowed fuel to enter the combustion chamber from the cooling jacket to provide additional film cooling of the chamber walls. The theory was fine, but we were getting explosions.

Our fix was the use of adhesive tape on the holes to prevent the flow of alcohol into the chamber during the time of jacket filling prior to ignition. And this ten-cent item solved the problem. Later, of course, a permanent fix was the use of cerrobend plugs in the hole which provided a positive seal and melted out when cooling was required. Since then the problem has disappeared entirely. None of Rocketdyne's present engines employs film cooling.

In those early days we fought problems which, in retrospect, seem almost childish. In the *Redstone* program it was necessary to cut off every test after approximately five seconds of operation because of continuously increasing injector face temperature. There were a great many sleepless nights before we traced the trouble to an accumulation of scale-type rust on the back-face of the injector. An interim fix was a careful post-run drying technique, and the permanent solution was the electroless nickel-plating of the injectors.

These are historical items now, problems which in their time seemed monumental. Our *Redstone* engine has enjoyed a remarkable success. More than fifty successful launchings have been accomplished. Not since the third launch has there been any trouble or delay due to a power plant failure.

So long as we continue in the research and development of rocket engines, we will continue to be involved in problems. They may vary in intensity, but they will always be with us. In general, our major problems can be reduced to these three: the continuance of high operational reliability, the problems occasioned by the ever-increasing engine sizes and thrust levels, and the changing demands made upon us in the field of thrust vector control.

This Rocketdyne laboratory is used exclusively for testing rocket engine components such as pumps, gas generators, etc. Behind the concrete walls of the remote-operated test stand are facilities for endurance testing of all auxiliary systems for the engines; excess gases are piped upwards through stacks and ignited.

Operational Reliability

One paramount objective that is always with us in our design and development work of new engines is continued reliability. When we press the firing button we want these engines to go — without quibbling, rumbling, or hesitation. Simplification of our engines has been an important goal. The *Thor* IRBM engine is a good example. In the beginning of its development phase in 1955, the *Thor* engine had 88 components. By 1958 these were reduced to 33. Next year we will have an engine with just 5 components. Each new engine model in every program shows an advance in simplicity over the previous model.

The Rocketdyne engine used in the first stage of the Army's *Explorer* satellite had been in storage for fourteen months prior to being placed upon the stand in Florida. The engines for nine *Redstone* missiles were delivered directly from the Rocketdyne assembly line to the launching pad. We're confident that these engines can be taken from the production line, placed in storage for periods up to five years — and still leap to life with the pressure of a finger on the firing button.

Combustion stability is one of the continuing problems we encounter in the striving for reliability. During normal operation of a liquid propellant rocket engine there are always fluctuations present in the thrust chamber pressure. Sometimes it is possible to see the fluctuations: you can always hear the resultant oscillations chugging or squealing or screaming.

When we encountered our first periods of rough combustion nine years ago we discovered that lock-wire fittings can loosen themselves and become completely unscrewed in a second. We found out that electrical relay and switch contacts, because of the violent vibrations, could become unreliable and cause a host of circuit and control problems. We watched one-thousand "g" accelerometers placed on the thrust chamber injector flange damaged beyond repair. As a result of serious study, we have been successful in developing special devices for controlling stability. The mechanism of rough combustion is well understood. You might say that the virus of the disease has been isolated, and antibiotics applied.

Clouds of steam rise from the water-cooled gas deflector plates on the left-hand stand, where a rocket engine has just been fired. The right-hand stand carries liquid oxygen and kerosene tanks for the *Atlas* ICBM.

The Big Engines

Only a short time ago when we spoke of "big engines" we were talking in terms of 150,000-lb. thrust. Suddenly the meaning of that phrase has changed. We're talking now in terms of single-chamber rocket engines developing 500,000-lb. thrust and 1,500,000-lb. thrust. We've found out that it is not possible to scale up existing engines and arrive at ready-made answers. We're encountering entirely different problems.

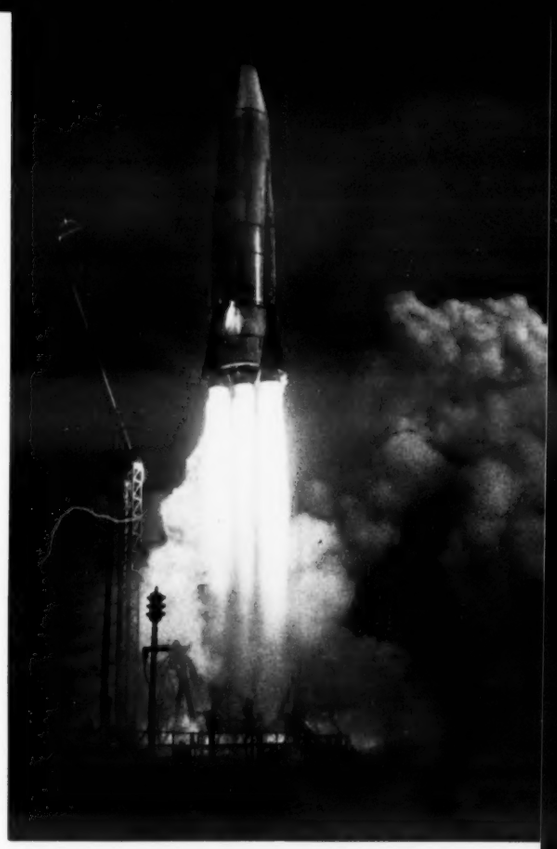
The physical size alone of the 1,500,000-lb. single chamber engine has uncovered entirely new problems in heat transfer, combustion stability, structural design, cooling requirements, gimbaling methods, nozzle configurations and fabrication techniques.

Let's consider just the one problem alone, that of heat transfer to the chamber walls. The thrust chambers in early missile programs were fabricated of heavy ¼-in. steel plate and fired without a cooling process. In later designs, the same plate, thinner but still cumbersome, was used with the addition of another wall, forming a hollow space through which coolant circulated. The method prevented chamber burnout effectively, but the penalty in added weight was prohibitive in an art which is so weight-conscious as is rocket engine development. A revolutionary change was necessary to reduce thrust chamber weight, while maintaining necessary cooling for the walls. The solution was the use of hundreds of extremely thin and light weight tubes banded together into an efficient thrust chamber. Besides dramatic weight saving, this tubular-wall design provided for optimum performance at extreme altitudes. The first complete engine using tubular chambers was test fired six years ago, in April 1953.

On our tubular-wall 150,000-lb. thrust chambers, used in the *Atlas* booster and other engines, the temperature within the chamber during firing may reach as high as 5,600 °F. Tube burning has been a major concern in our tubular-wall thrust chamber development. As we climb upward through the thrust levels in these new engines being proposed, the density of gases, temperature, and gas-side heat coefficient increases. The pressure within coolant tubes has more than doubled. The heat-transfer processes and thermal characteristics of various fuels and oxidizers at high pressures and temperatures within these thin small-diameter tubes have been thoroughly explored at Rocketdyne, and our plans are well advanced for coping with the situations presented by the new extremely high-thrust engines.

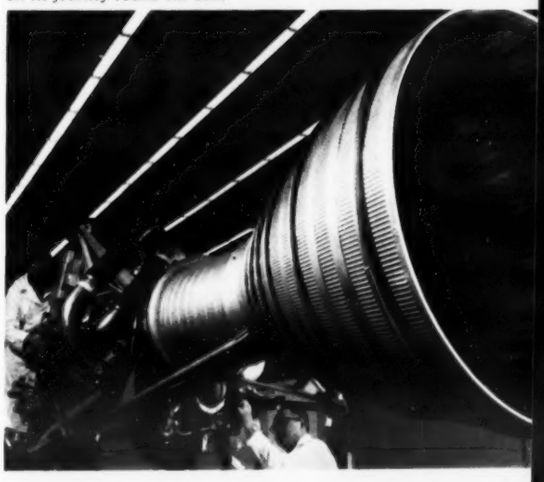
Gimbaling or Attitude Control

Attitude control of large rocket engines has become a greater problem now that we are

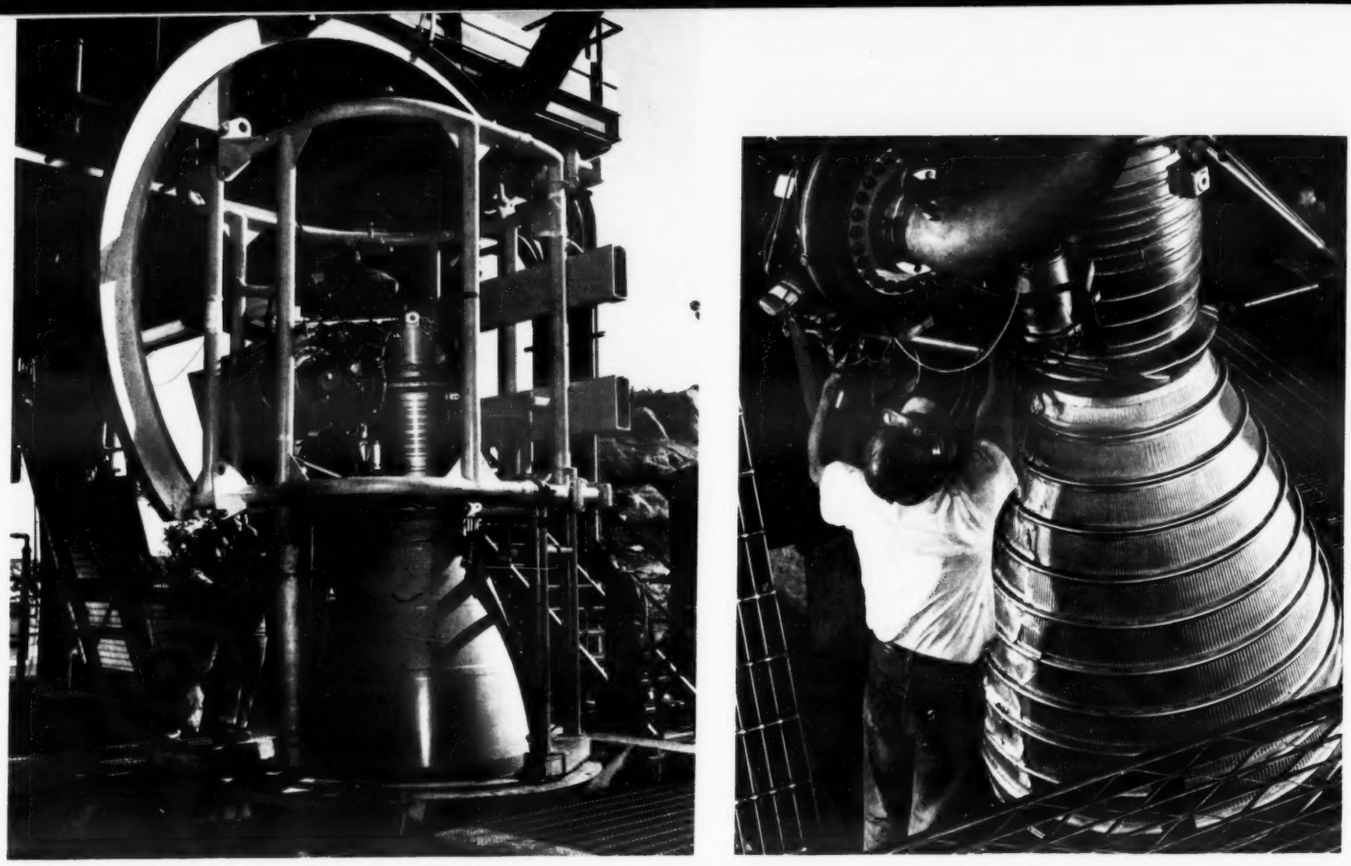


An *Atlas* intercontinental ballistic missile is launched by three Rocketdyne engines on a 5,000 nautical mile test operation.

Final adjustments to the rocket engine for a *Jupiter* IRBM at Rocketdyne's Canoga Park plant. An engine of the same type launched the *Pioneer IV* space vehicle on its journey round the sun.



The three power units for the *Atlas* ICBM (on either side the two boosters, center the sustainer unit) together deliver 360,000 lb. of thrust.



First picture of the new H-1 rocket engine (thrust 187,500 lb.), a simplified and more powerful version of the proven *Thor* and *Jupiter* engine. Eight of these units will be clustered to form the giant first stage booster for the Army/ARPA *Saturn* rocket. The left-hand picture shows an H-1 complete with propellant pump on a Propulsion Field Laboratory static test stand.

involved with engines of much higher thrust and longer duration. In order for the missile to reach maximum range, it must start its free flight, or power-off cycle, with a certain optimum angle of elevation. Thrust vector control is utilized to direct the thrust so that proper missile take-off and trajectory can be achieved. It is this method of control which has claimed our greatest interest and activity at Rocketdyne.

Any system employed in the missile, and especially the rocket engine thrust vector control system, must have high reliability, minimum weight, and minimum power requirements. None of these presents an insurmountable problem. However, when high loads, large variations in environment, speed of response, minimum actuator power requirements and other conditions are considered, the problem becomes more complex.

In our early engine programs, jet vanes, similar to those used in the German V-2 missile, were satisfactory. They are still eminently practical in the current *Redstone* engine. The G-26 version of the *Navaho* engine also used jet vanes. However, as the duration of firing time was extended it became apparent that no material was available for the vanes which would withstand the punishment imposed on them. Then, too, the drag imposed on the missile became prohibitive. It became apparent that other methods of control would be required.

Rocket engine designs were presented in which the chamber was mounted on a gimbal bearing, and the direction of thrust varied by movement of the chamber. This offered pitch and yaw control. A vernier system, utilizing miniature rocket engines mounted on either side of the exterior missile envelope, provided roll control. The gimbal system in use on today's *Atlas* engines evolved through a process of trial and error. The configurations attempted finally led to a bearing which has been eminently satisfactory for a most exacting requirement. In passing, it should be noted that gimbaling was once thought to be an impossibility.

Yet the successful development of a gimbal bearing brought, in its turn, new problems to our rocket engine designers. Propellant tanks were fixed; thrust chambers were gimbaling, swinging in wide arcs. Rigid propellant lines between the two were impossible. This led to an entirely new concept in high-pressure flexible ducting between propellant tanks and thrust chamber. Corrugated flexible hose, capable of withstanding a pressure of 1,000 psia, was utilized in the final configuration. This seemingly minor advance was actually of major importance, a forward step that was accomplished in extremely short time, pushed onward by the urgency of the *Atlas* program.

Propellant Evolution

Initial testing at Rocketdyne's Propulsion Field Laboratory, back in 1950, was accomplished with engines that utilized liquid oxygen and alcohol as propellants. When development work on the original 120,000-lb. thrust engine was started shortly thereafter, the need for better logistic supply and higher performance prompted a change to the liquid oxygen/JP-4 combination. Four years later, when work was started on the *Atlas* program, the fuel specified was JP-5, a high boiling hydrocarbon blend in the kerosene range. JP-5 is a jet engine fuel, its specification being originally established without consideration or knowledge of the fuel requirements of large rocket engines. After the *Atlas* program was initiated, the need was demonstrated for the specification of a proper fuel to be used in rocket engines.

An analysis of engine and gas generator test results conducted in Rocketdyne's laboratories showed conclusively that, in terms of reliability, reproducibility, and performance, JP-5 had severe shortcomings. This led to the recommendation of a new specification for a mixed, commercially available hydrocarbon fuel in the JP-5 boiling range. This specification has now been designated by the Air Force as RP-1, the first designation to be established specifically for rocket engine fuels.

This new, highly volatile, fuel has been directly responsible for the high levels of power being reached by *Atlas* engines.

1,500,000-lb. Thrust Engines

Rocketdyne is currently developing two superbooster rocket engines each capable of developing up to 1,500,000 pounds of thrust. The first,

destined for use with the *Saturn* space vehicle, is composed of a group of eight engines built from existing *Thor* and *Jupiter* engine components. The Advanced Research Projects Agency has authorized the Army Ballistic Missile Agency to develop this booster, and Rocketdyne was awarded the contract for the basic engine. Delivery of the first engine – part of the group of eight – has already been made to ABMA.

Normally it takes a minimum of five years for a rocket engine to advance from the drawing board to the testing stage, but by building from existing components of the *Thor* and *Jupiter*, the *Saturn* booster will be ready in far less time. The engine is extremely simplified for the utmost reliability.

This *Saturn* booster will be capable of placing a five-ton payload into a 22,400-mile earth orbit, or landing a one-ton payload on the moon.

A second development effort at Rocketdyne, a single-chamber liquid propellant engine with a thrust capability up to 1,500,000 pounds, is being conducted for the National Aeronautics and Space Administration.

This engine will require a tremendous development effort. Larger test stands will be needed. Turbomachinery capable of power outputs of small municipalities will be required to feed the propellant to the chamber. Stable combustion chambers will have to be built with combustion densities many times that of existing engines. Plumbing and valves will be beyond the range of current experience.

However, we are confident that all the problems will be solved, and we will proceed from these giants of today to even more powerful engines in the near future.

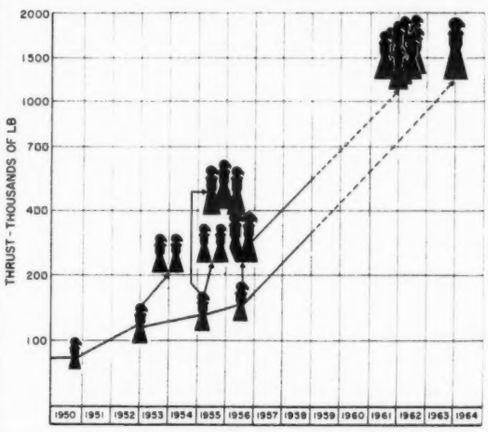
The Next 25 Years

At the 27th Annual Meeting of the Institute of the Aeronautical Sciences, held in New York at the end of January this year, T. F. Dixon read a paper* dealing with the probable development of rocket engines during the coming 25 years. He forecast that the clustered super boosters of 1,500,000 lb. thrust *(Saturn)* and 6,000,000 lb. thrust *(Nova)* projected today will inevitably be followed by still bigger units, that in about 10 to 15 years' time a single-chamber rocket motor will deliver as much thrust as the four first-stage units for the *Nova* combined. Man's insatiable curiosity will then doubtless lead him to cluster say four of these 6,000,000-lb. engines and finally—in about 25 years—to a single unit producing more than 20,000,000-lb. thrust. The latter giant, barely conceivable today, would be capable of placing a 300,000-lb. payload into a satellite orbit or carrying 60,000-lb. around Mars and back to earth.

Exactly how all this will be done Mr. Dixon does not venture to suggest. It seems likely, however, that "space ships" of this kind will have to be assembled, and perhaps even manufactured, at the launching site, in much the same way as seagoing vessels are constructed in shipyards from which they are launched. In these giant rocket motors many components and accessories will probably have to be combined with the combustion chamber, whose walls will be built up of cells, like human skin.

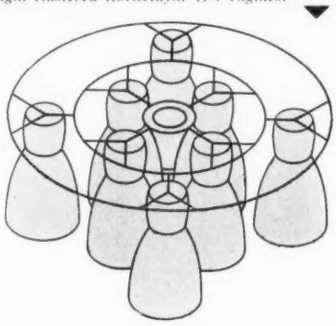
As, however, the specific impulses obtainable with conventional liquid-propellant rockets are limited (280 to 350 sec), dimensions of vehicles for most space missions will become gigantic—to provide space for the huge quantities of propellant required. Rockets using hydrogen heated by a nuclear reactor as propellant would have a specific impulse of more than 800 sec, and will probably displace the chemically-propelled rockets; still later means of propulsion will doubtless be thermonuclear engines and other plasma power units, which will finally bring true man's ancient dream of travelling to distant worlds.

* T. F. Dixon: "A Look at Rocket Propulsion for the Next 25 Years"; IAS Report No. 59-54.

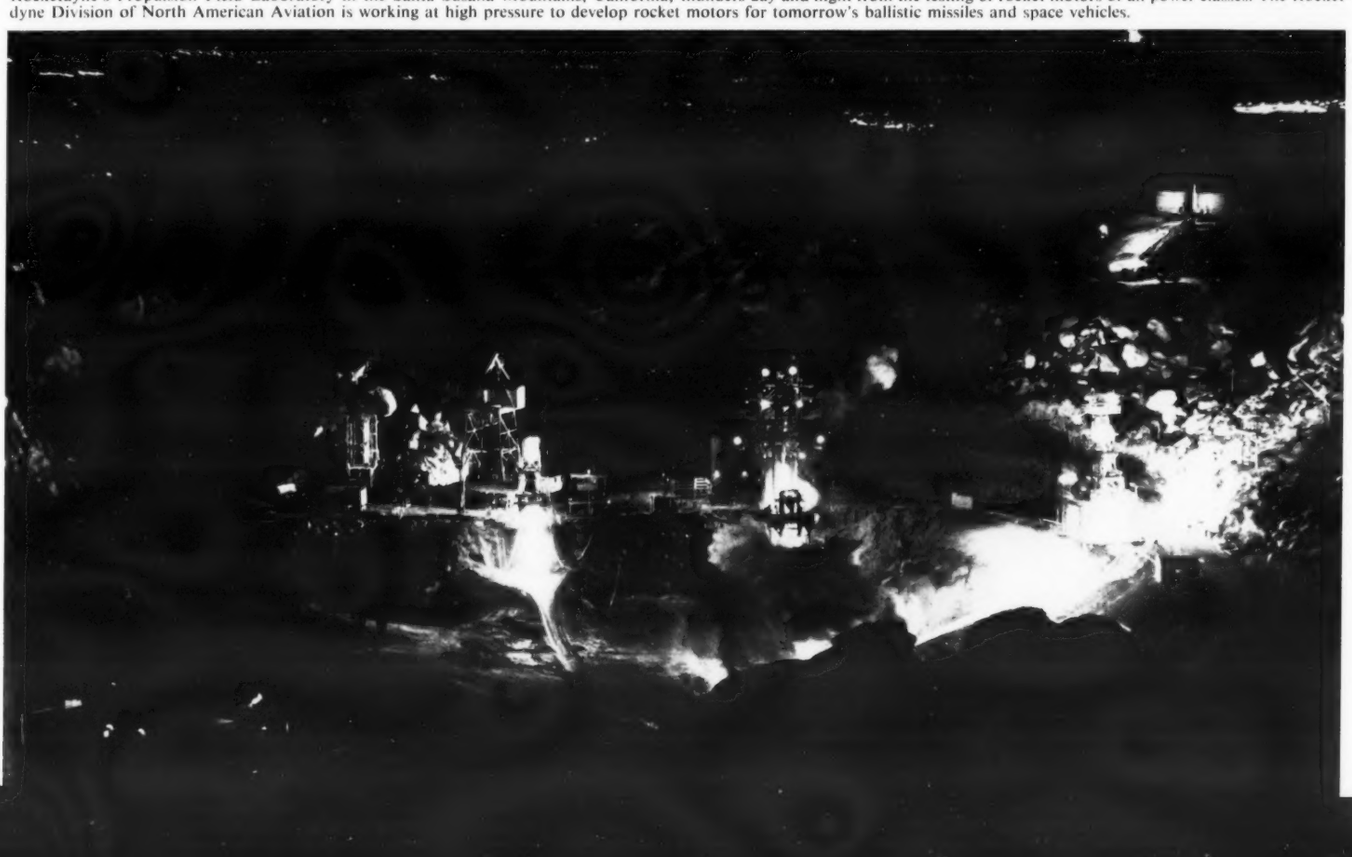


Growth in thrust of Rocketdyne's engines (in 1,000 lb.). Initially, major increases in thrust could be obtained only by clustering a number of separate units, but in a few years' time single-chamber engines with thrusts of up to 1,500,000 lb. will be available.

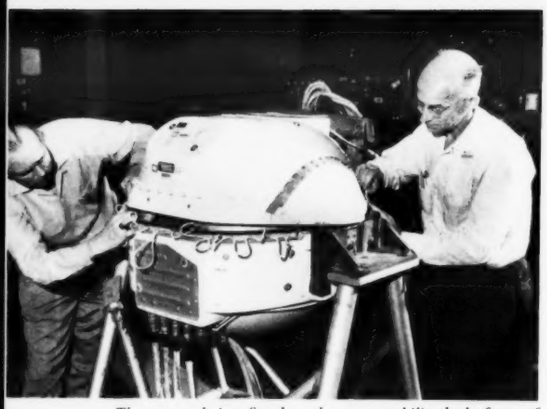
This diagram of the Saturn *booster, now under development, shows the arrangement of the eight clustered Rocketdyne H-1 engines.*



Rocketdyne's Propulsion Field Laboratory in the Santa Susana Mountains, California, thunders day and night from the testing of rocket motors of all power classes. The Rocketdyne Division of North American Aviation is working at high pressure to develop rocket motors for tomorrow's ballistic missiles and space vehicles.



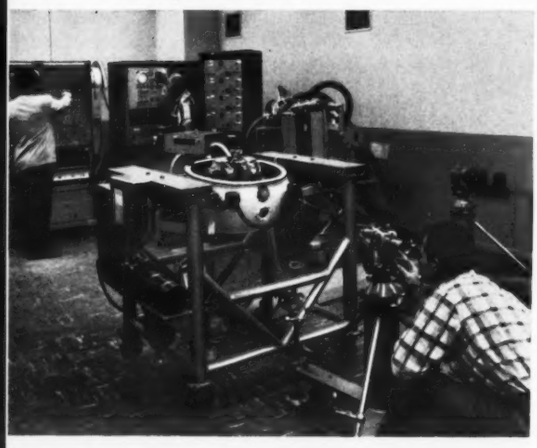
Inertial Guidance for Long-Range Aircraft and Missiles



The covers being fitted to the gyro stabilized platform of the N6A Inertial Navigation system developed by Autonetics Division of North American Aviation Inc. The platform's function is to maintain angular orientation relative to the earth.

The unit with the covers removed. Prototype models of this system were proved in the U.S. Navy vessel U.S.S. Compass Island *and in the North American X-10 robot missile and the* Navaho. *It is also used in the* Nautilus *nuclear submarine.*

An NAA lightweight stable platform being function tested by means of precision optical survey equipment. The electronic equipment and computer seen against the right hand wall completes the system.

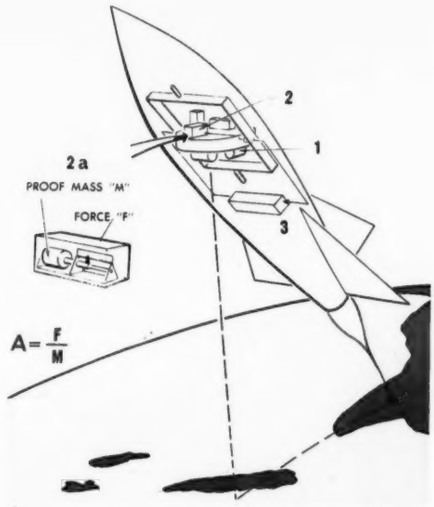


Long-range surface-to-surface weapons powered by air-breathing engines, such as the Northrop SM-62 *Snark* (Mach 1) and the North American SM-64 *Navaho* (Mach 3), now abandoned, cannot be remotely controlled by radio from a ground station, but must be supplied with their own pre-programmed automatic guidance systems. The reason for this is not only the fact that the micro-waves which alone can be used for remote control are propagated in straight lines and cannot follow the earth's curvature; a more important argument against remote control, whether on a beam or by radio command, is the vulnerability of radio operation to atmospheric disturbances, particularly those caused by magnetic storms, and to enemy ECM (electronic countermeasures).

On the other hand, the accuracy requirements as regards the burnout data for intercontinental ballistic missiles or even space vehicles, in particular as to height, distance, speed, course and elevation on burnout, are so strict that high-precision automatic navigation and control systems are essential. If, in the case of the V2, with a range of only around 150 miles and a powered phase of about one minute, it was possible to keep the missile on course with the aid of a 50 Mc/s beam and to rely on the pre-programmed automatic pilot for the remaining factors, such a procedure would be thoroughly unreliable in the case of the *Atlas* and *Titan* ICBM's with ranges of approximately 6,000 miles and powered phases lasting several minutes. The required degree of accuracy is, however, the same as that for the V2, though the distances are about 40 times greater. It is, of course, possible to control the flight path of a rocket only during those brief periods when the rocket engines of the main propulsion system are operating, in other words during the burning periods of first stage, second stage and so on. The small auxiliary rockets (Vernier rockets) of the ICBM are capable only of roll or attitude control and last-minute flight speed corrections on burnout.

Of the three automatic navigation systems working *without* airborne radar—navigation by dead reckoning, celestial navigation, inertial navigation—the last is the one used in supersonic air-breathing and hypersonic ballistic missiles. Due to wind effects—powerful jetstreams are encountered at high altitudes—navigation by dead reckoning (quite apart from the doubtful reliability of the compass reference) is too inaccurate, and celestial navigation, based on the measurement of the angle of a star to the local vertical, is suitable only for relatively slow-moving aircraft or ships. Inertial navigation, on the other hand, is based neither on estimation of certain factors like navigation by dead reckoning, nor on external points of reference like celestial navigation, but on the only values which can be directly measured aboard the moving body itself, namely magnitude and direction of acceleration at any given moment. If the accelerations occurring during the flight and their variation in magnitude and direction are measured continuously, i.e. quantitatively referred to a triaxial coordinate system stabilized relative to the earth or a fixed star, the speeds developed along the three axes of the reference system are obtained by integrating all accelerations over time, and the flying speed is the vectorial sum of these components. In addition, the course travelled over the ground (in the case of an earth-referenced system) and the height at any given moment, can be calculated by further integration—namely of speed over time.

The accuracy of inertial navigation systems depends in the first place on the precision with which the acceleration measurements can be made along the three axes of the reference system, in the second place on the quality of the electronic computers and automatic control equipment. The critical elements are thus the accelerometers (dynamometers or integrating gyros) and the stabilizing gyros of the reference system, in which the random drift must be infinitely small. In the first inertial navigation systems, constructed by MIT (Massachusetts Institute of Technology) and incorporated in a B-29 *Superfortress* as early as 1953, these requirements necessitated a weight of approximately 2,600 lb., but some modern American and British lightweight systems weigh as little as one twentieth of this.



Schematic diagram of a self-contained North American inertial navigation system for robot missiles: *The gyro stabilized platform (1) which due to its "equatorial mounting" (flight path computer, chronometer, and servos) is maintained perpendicular to the local vertical in spite of the high speed of the missile over the earth's surface and the relative rotation of the earth beneath. On the platform are three accelerometers (2) mounted with their axes in mutually orthogonal directions. The accelerometers continuously measure the accelerations in the direction of the missile's flight over the ground, at right angles to it (fig. 2a) and parallel to the local vertical (for height computation). By integrating these measurements over time, a computer (3) calculates the velocity components parallel to the three sensitive axes, and by a further integration of the velocity components the ground distance travelled and the height.*

The following are some of the firms now producing inertial navigation systems. USA: A.C. Spark Plug, American Bosch Arma, Bendix, General Electric, North American (Autonetics Div.), Northrop (Nortronics Div.), Minneapolis-Honeywell, Republic, Sperry (and its subsidiary Ford Instrument). Great Britain: English Electric, Fairey, Honeywell-Brown, Plessey. In addition, components for inertial systems are supplied by Bell Telephone, Lear, Lockheed, Motorola and Texas Instruments.

The details of most of the systems are by their nature subject to military secrecy, although some photographs or rigorously censored articles have been passed for publication. In these pages are shown some interesting pictures of inertial equipments manufactured by the Autonetics Division of North American, supplemented by two articles by engineers of the American Bosch Arma Corporation and the Northrop Corporation. Readers are likewise reminded of articles published in earlier issues (No. 6/1957, 575 et seq. and No. 6/1956, 447 et seq.).

In closing it should be mentioned that the inertial equipments shown are designed first and foremost for continuously powered aircraft or ships, in particular nuclear submarines. For intercontinental missiles and space vehicles, with their short propulsion phases, simplified installations are quite adequate (for instance they can dispense with the chronometer giving correction for the earth's rotation). An automatic guidance system of this kind, designated the 'Delta Minimum Inertial Guidance Scheme ', was used in the successful launching of the *Juno II* vehicle for the U.S. Army's artificial planet *Pioneer IV* on March 3rd, 1959.

Reliability in Inertial Systems

by A. M. Voutsas and W. T. Chow, Garden City, New York

For ballistic missiles and space vehicles to accomplish their missions, they must be guided during powered flight with a high degree of accuracy. In both cases the navigation and guidance requirements are similar and can be satisfied by similar means. One of the important techniques used for the navigation and guidance of both is Inertial Navigation.

Inertial Navigation is a self-contained dead reckoning system capable of very high accuracies. The inertial guidance system consists of the airborne equipment for sensing and computation, and the ground equipment for pre-flight calibration, checkout and initial coordinate alignment. The airborne portion of the inertial guidance system continuously computes the vehicle velocity and position from launch throughout powered flight and guides the vehicle. For a long-range ballistic vehicle of 5,000 miles range, if this burnout velocity is missed by the order of a foot per second, the target will be overshot by a mile.

The airborne equipment consists of two major subsystems; the inertial platform and the computer. The platform is stabilized in space or relative to the Earth with gyros through a three-axis gimbal system.

Three accelerometers mounted in mutually orthogonal directions on the platform are used to sense the motion of the vehicle in space. The accelerometer outputs are processed by the guidance computer together with some preset values to obtain the signals for the proper control of the vehicle during its flight. By referencing these accelerations to the gyro stabilized inertial reference directions, computations as to present position and velocity are continuously performed from the time of launch throughout powered flight. These data are used by the computer to command the vehicle to a predetermined velocity and position in space.

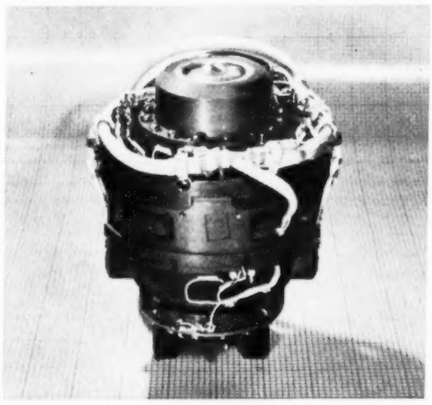
The main advantages of the inertial method of guidance are complete independence of atmospheric conditions, independence of the need for a ground station and the impossibility of the system to be jammed. Once set on a desired course, it will proceed undisturbed and undetected. Its safe operation depends only on the accuracy and reliability of the system.

As early as 1951, the American Bosch Arma Corporation foresaw the need to develop a practical inertial guidance system using digital computers and to determine its accuracy and operational limitations. By 1952, the design criteria for such an inertial guidance system were crystallized. Shortly thereafter, Arma was given a contract to develop the entire inertial guidance system for a ballistic missile.

As the development was directed to the design of digital computers, severe technical problems arose because knowledge on digital computers at that time was very limited. A vibrating reed accelerometer was pioneered because of its simplicity, ruggedness and absence of rotating parts. Its digital output made it an extremely accurate instrument when used in conjunction with a digital computer.

A vital contribution to this program was the existence of the Arma *fluid suspended gyro*, possessing the required ruggedness and accuracy. This Arma two-degree-of-freedom gyro permits the development of a stable platform using only two gyros instead of the conventional three.

Reliability has been emphasized in the development program to the point where it is considered as a major design parameter; extensive investigations have been made into the materials and processes to be used in the fabrication of computers, gyros, accelerometers and platforms. Materials have been developed to meet such requirements as vibration damping, moisture resistance, thermal conductivity, inhibition to corrosion and resistance to nuclear radiation. Automatic test equipment which can monitor several thousand components at once have been designed and constructed. To date, approximately 400 million component hours have been accumulated in computer component tests. Data of these tests after processing in IBM electronic computers are used in circuit design.



An exterior view of the American Bosch Arma two degree of freedom fluid suspended gyro.

A supersonic rocket sled being used to test components of the system at the Naval Advance Research Track in California.

To achieve a high degree of reliability, all electrical circuits in the guidance equipment are transistorized. In the physical design, detailed considerations are given to factors such as shock and vibration environments, the characteristics and resonance frequencies of the subassemblies and the supporting structures of the equipment.

Manufacturing techniques have been evolved to greatly reduce component handling. Assembly is accomplished in segregated areas where cleanliness, temperature and humidity are closely controlled. Specifications on materials, printed wiring, dip soldering, ultrasonic cleaning and other manufacturing processes were established. All materials and components are subjected to a 100% operational test on a non-destructive basis. A sampled test from each lot is made on a destructive basis.

Finally, a precision centrifuge was developed for testing and calibrating guidance equipment under high acceleration environment.

In Arma's environmental laboratory, actual conditions occurring in space are reproduced. Varied types and combinations of environment which the system will encounter are simulated. This laboratory includes both high and low temperature test chambers, altitude and humidity chambers as well as facilities for testing rain, salt spray, fungus, radio interference, shock and vibration environments. A walk-in altitude chamber enclosing a complex vibration facility is capable of achieving an altitude of 120,000 feet from sea level within a period of four minutes while subjecting the individual component or system to combined programmed and random vibrations.

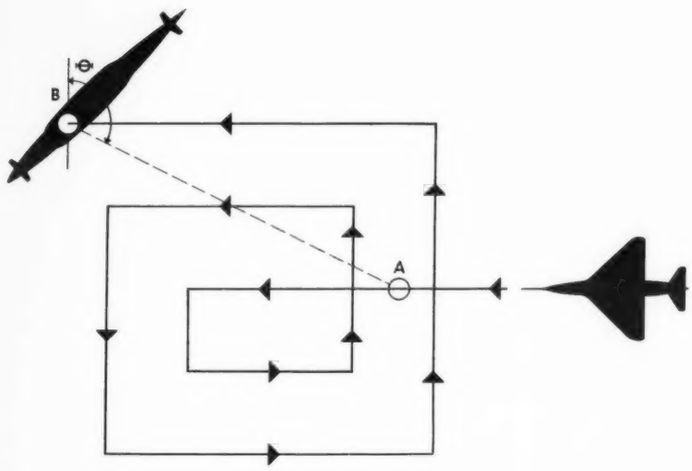
In addition, out of plant facilities are utilized for specialized tests. Acoustic noise tests were performed at the *NASA* facility at *Langley Field, Virginia.* A components test program using supersonic rocket sleds was conducted at the *Naval Ordnance Research Track* in California and nuclear radiation tests on computer components were performed at the *Brookhaven National Laboratories on Long Island, N.Y.* Overall system integration tests are performed in Arma's *Computational Laboratory* which has facilities for both digital and analog mathematical analysis and for simulating aerodynamic and guidance problems.

The Arma all inertial system is suitable for the navigation and guidance of ballistic missiles and for a variety of space vehicles. For other manned or unmanned astronautical missions, additional aids will be incorporated such as Doppler corrections for early stages of flight, star tracker readings for mid-course guidance and homing devices for the terminal phase.

LINS — Lightweight Inertial Navigation System

The most recent product of Nortronics' twelve years experience in navigation systems for inter-continental weapons is a lightweight inertial navigation system (LINS). This system, now in prototype testing, has widespread application for both short and long range military applications. It is a complete, self-contained navigation system weighing only 124 lb. and occupying a space no greater than 2.7 cu. ft.

The LINS system consists of four essential packages: an inertial instrument, a platform electronics unit, a digital computer, and the visual control and display units.



Pattern of typical expanded anti-submarine square search by tracker aircraft. By inserting the coordinates of a checkpoint at the commencement of the search, the LINS unit will continue to compute and indicate the bearing and distance of that point while the search pattern is being flown. By setting the coordinates of the point A in the control console the azimuth (Θ) and the distance BA will be indicated on the pilot's display when the target is identified.

LINS is a versatile digital system that has no geographical limitation to its deployment. The 4-gimbal *inertial platform* assures full craft attitude freedom. The *airborne digital computer* consists of a digital differential analyzer (DDA) and a general purpose computer (GPC) which operates in the binary number system. These two computers share a common magnetic drum memory, and the system is so designed as to require no manual intervention as it is automatically sequenced through the modes of computation. The *pilot's display* for manned aircraft application consists of two lightweight packages: one instrument panel meter displaying range and course to the destination, and one console control for setting and display of latitude and longitude of present position and destination.

In setting up the system for a mission, target or destination coordinates are dialed into the control unit. In manned applications, these coordinates can be changed at any time during flight. Once the craft is airborne, the pilot's display unit provides target range and bearing information. Checkpoint information can also be fed into the system at any time. This feature is particularly useful on extended flights in which platform drift can adversely affect the required accuracy.

One of the major operational advantages of this inertial system is rapid reflex. The system is capable of meeting accuracy requirements for a mission after a three minute period of ground operation. As with all pure inertial systems, however, accuracy increases with the duration of the ground alignment period.

The LINS system has been designed for ease of maintenance and rapid ground alignment. Ground alignment is performed by a portable unit and no special alignment area at the base site is needed.

Four modes of ground calibration and alignment have been selected for the lightweight inertial system.

The *precision navigation mode* entails a minimum system checkout, an optical azimuth calibration, and a gyro rate calibration. The *gyrocompassing mode* is similar except that the system is calibrated by using the Earth's angular velocity as a reference. The *fast reaction mode* involves a minimum system checkout in addition to an optical azimuth alignment. The *scramble mode* requires only a rapid system checkout and heading alignment. While the fast reaction and scramble modes of alignment imply a degradation of system accuracy, it is possible for the pilot, while airborne, to improve the accuracy by inserting checkpoint information.

The precision navigation and gyrocompassing modes require sufficient advance notice of the mission. The fast reaction mode anticipates some operational urgency. The scramble mode of calibration and alignment anticipates an immediate take-off order.

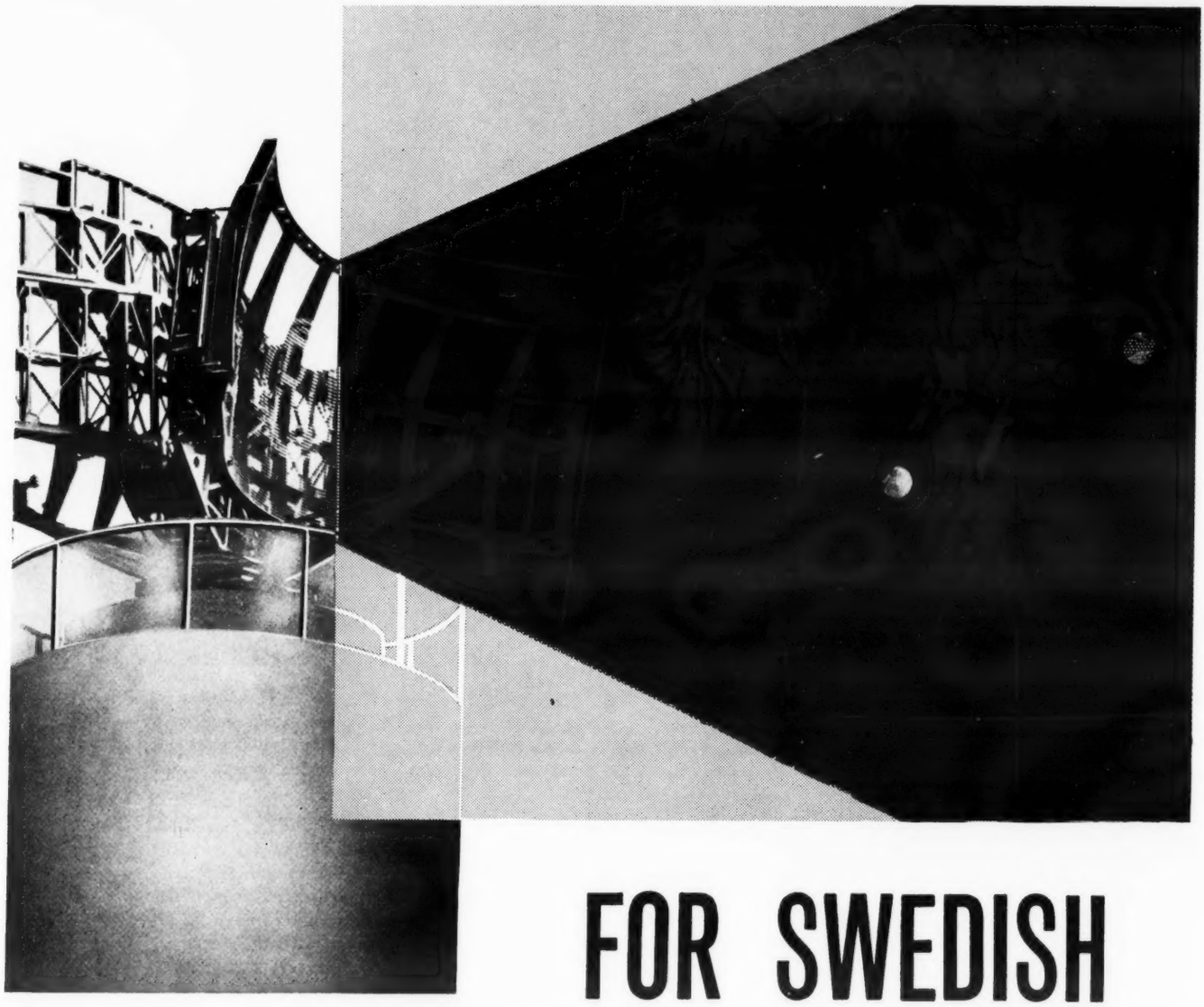
The LINS system has been designed with specific attention to the navigation and stable reference requirements of high performance aircraft. Consider the *fighter-bomber* mission, for example, where all-weather operation is required. Sufficient navigational accuracy must be achieved to permit low altitude approach and location of the target. A high performance, all-attitude reference is needed to furnish accurate, instantaneous vertical velocity for toss bombing and a stable reference and navigation throughout the dynamic range of evasive maneuvers.

The *intercept* or *counterair* mission imposes equally stringent requirements for navigational accuracy and all-attitude performance. In such operations as anti-submarine patrols extremely accurate local search patterns must be flown to detect a suspected target in the shortest possible time.

For the majority of commercial operations and military operations of *extended range* and flight times, a lightweight inertial navigation system is feasible. Base-to-base flights or jet airliner operations are seldom longer than eight hours. The accuracy of the LINS system is sufficient to bring the longest flights well within the range of the navigational aids available at an airbase under all conditions.

In addition to the applications already mentioned, LINS can be used by various classes of missiles. Since the guidance requirements for decoy missiles are less restrictive than for armed vehicles, the LINS equipment may be used for long-range decoys. Short range surface-to-surface weapons and air-to-surface weapons can utilize this lightweight inertial system when adequate alignment and calibration are provided.

DECCA RADAR



FOR SWEDISH AIRWAYS

50,000 feet at 130 nautical miles—such is the gap-free coverage of the new Decca Civil Terminal Surveillance radars for a target equivalent to a medium sized airliner.

Now being installed for the Swedish Board of Civil Aviation at Stockholm and Gothenburg, and also ordered for Malmo, the Decca D.A.S.R.1 has an outstanding performance and will be capable of fulfilling its exacting all-weather role in international terminal areas for many years to come.

Wherever control authorities are equipped with this exceptional, long range, high discrimination radar, airline operators will be assured of realising the full performance and economy of modern airliners, even in areas of high traffic density.

DECCA BUILD GREAT RADARS

DECCA RADAR

DECCA RADAR LIMITED · LONDON · ENGLAND

In The Airlanes of the World...

Bendix

PROVIDES

You are flying today in the finest of airliners . . fitted with the best of equipment . . . with your mind's eye on the future. And although you marvel at the performance of your navigation systems, your communication equipment, the speed and efficiency of your engines . . . you yearn for even finer and greater things to make your flights more dependable and your equipment even more reliable.

Bendix has that same thought for the future, and all the while is devoting its efforts to produce " reality " for you. The part of Bendix in the technical progress of aviation is vast and varied. Because Bendix always anticipates aviation's next advance, every plane that flies, in some way relies on Bendix' creative engineering.

Even before takeoff, Bendix' weather instruments provide the vital data for flight plans. Bendix filters guard the fuel used by engines equipped with Bendix starters, generators, ignition and fuel metering. In flight . . . Bendix airborne weather radar, automatic pilots, instruments, radio, actuating mechanisms, de-icing equipment, and other scientific devices surround planes with safety and guide them to countless landings cushioned by Bendix landing gear. And, with increasing frequency, Bendix Flight Path Control and GCA are used to bring planes safely to runways in bad weather.

Bendix is first in fuel metering systems for Jets, Ram-Jet and Turbo-prop engines. A leader in landing gear. The largest producer of Aviation Instruments and Accessories which have become the standard for major airlines. When you see the " Bendix Aviation Corporation " name on any product, you can buy and use that product with the complete assurance that it is the final word in creative engineering.

• • •

From the intimate knowledge of aviation progress gained through this active participation, Bendix can assure you that today's engineering triumphs are looked upon merely as stepping stones—and Bendix will continue to play an important part in aviation advancement.

Bendix International

Quality... OUR MOST IMPORTANT PRODUCT

RELIABILITY...

...in COMMUNICATIONS

VHF Radio Transmitters & Receivers • Aircraft Interphone Systems • Audio Control Panels
Passenger Address Systems • Amspeakers • Antennas

...in NAVIGATION

Weather Radar • Automatic Radio Compass Systems • Distance Measuring Equipment
Marker Beacon Receivers • VHF Omni-Range Equipment • VHF Ground Direction Finders
Glidescope Receivers • Micro-Wave Equipment • Automatic Direction Finder Systems
Indicators • Computers • Automatic Pilot Systems • Central Air Data Computers
Polar Path Compass • Supersonic Flight Control Systems • Sonic Altimeters

...in ENGINE COMPONENTS

Direct Injection Fuel Systems • Fuel Metering Systems • Jet Engine Control Analyzers
Carburetors • Fuel-Flow Totalizing Systems • Engine Starting Equipment • Magnetos
Ignition Analyzers • Ignition Systems • Dynamotors • Electrical Connectors

...in AIRFRAME PARTS

Hydraulic Actuating Equipment • Shock-Absorbing Struts • Hydraulic Master Cylinders
Landing Gear Wheels • Cerametalix Brake Lining • Power Brake Valves • Rotor Type Brakes

We would like to tell you about these and the many other products and systems that have made Bendix and Aviation synonymous around the world.

Bendix International

DIVISION OF BENDIX AVIATION CORPORATION

CABLE "BENDIXINT", NEW YORK

*Registered Trademark Bendix Aviation Corporation

205 EAST 42ND STREET **NEW YORK 17, N. Y., U. S. A.**

BELL'S ALL-NEW MODEL 204

TODAY'S LEADING PRODUCTION HELICOPTER

Proof of Bell's leadership in the helicopter field is its brilliant new turbine-powered Model 204 helicopter. Designed to meet the most exacting standards of performance and maintenance ever required of a helicopter — put through more rigorous and realistic tests — the 204 is today's leading production helicopter.

Greatly simplified in maintenance and low cost in operation, the 204 features 1,000 hours between major inspections — fast, easy parts replacement. Low in silhouette, extremely fast and maneuverable, the 204 has outstanding high altitude and hot weather performance — all-weather flight instrumentation.

Built expressly for U. S. Army use and designated the HU-1A, this new Bell is now in full production for the military. And because the U. S. Army demanded and would accept only the best, the 204 has performance and engineering refinements no other helicopter possesses. From this all-new Bell will come far-reaching benefits for business and industry. Look to Bell for the best in helicopters — leader in the field with over 2,500,000 hours of flight experience in 52 countries of the world.

BELL Helicopter CORPORATION

FORT WORTH, TEXAS | **SUBSIDIARY OF BELL AIRCRAFT CORPORATION**

Exclusive U. S. factory representative in Germany, Motorflug, G.m.b.H.

BELL DEALERS AND REPRESENTATIVES THROUGHOUT THE FREE WORLD

ARGENTINA, Buenos Aires
* Aerotransportes Wollkopf
AUSTRALIA, Queensland
Frank V. Sharpe
AUSTRIA
Forrer-Fenwick, S.A., Zurich
BAHAMA ISLANDS, Nassau
International Agencies, Ltd.
BELGIUM, Brussels
Aerobel
BOLIVIA, La Paz
Federico A. Eulert S. en C.
BRAZIL, Rio de Janeiro
Companhia Carnasciali
BURMA, Rangoon
Jing Hong Trading Corporation
CHILE, Santiago
Sociedad General de Comercio, S. A.
COLOMBIA, Bogota
* Antonio Angel & Cia, Ltda.
COSTA RICA, San José
Miguel Yamuni T.
CUBA, Havana
Mario Santamaria
DENMARK, Copenhagen
Leon Jorgensen
DOMINICAN REPUBLIC
Ciudad Trujillo
C.I.M.I.C.
EGYPT AND SYRIA, United Arab Republic
Group Capt. M. Salah E. Farid, Cairo
ENGLAND, Gloucester
Hordern-Richmond, Ltd.
ETHIOPIA, Addis Ababa
* Ethiopian Air Lines
FRANCE, Paris 15e
* Fenwick Aviation
GERMANY, Koblenz
* Motorflug, G.m.b.H.
GREECE, Athens
K. Karayannis
GUATEMALA, Guatemala City
La Compañia de Helicópteros
HAITI, Port-au-Prince
Fortuné L. Bogat
HOLLAND, Rotterdam
Messrs. Thalassa N. V.
INDIA, Bombay
Commandant General M.J.B. Maneckji
INDONESIA, Djakarta
Indonesian Planning Office, Ltd.
IRAN, Tehran
Salar Bahktair
IRAQ, Baghdad
Atlas Company, Ltd.
ISRAEL, Tel-Aviv
Cidev Company, Ltd.
ITALY, Gallarate
* Costruzioni Aeronautiche Agusta
JAPAN, Tokyo
* Mitsui Bussan Kaisha, Ltd.
JORDAN, Jerusalem
Egor J. Farradj
KOREA, Seoul
Yong Wook Shinn
KUWAIT, Kuwait
International Trading Agency
MEXICO, Mexico City
Aeromex, S. A. de C. V.
NEW ZEALAND, Auckland
* Seabrook Fowlds, Ltd.
NIGERIA, Lagos
Air Stock West Africa, Ltd.
NORWAY, Oslo
Scancopter A. S.
PAKISTAN, Karachi
Ali Automobiles, Ltd.
PANAMA, Panama City
Col. C. H. Deerwester
PARAGUAY, Asunción
Nicolas Bo, S. A.
PERU, Lima
Inter-Continental Trade Co., S. A.
PHILIPPINES, Manila, Luzon
Campos Rueda & Sons
PORTUGAL, Lisbon
Daun Limitada
PUERTO RICO, San Juan
Caribe Helicopter Sales
SAUDI ARABIA, Al Khobar
General Contracting Co., Ltd.
CENTRAL AFRICAN FEDERATION, Kitwe, N. Rhodesia
Autair Helicopters, Ltd.
SPAIN, Madrid
Iberavia, S. A.
SURINAM, Paramaribo
Koopmann & Company
SWEDEN, Stockholm
* Ostermans Aero A.B.
SWITZERLAND, Zurich
Forrer-Fenwick, S. A.
THAILAND, Bangkok
T. P. Karnasuta
TRINIDAD, Trinidad
Caribbean Continental Trading Co.
TURKEY, Ankara
Polar Mining and Industrial Corporation
URUGUAY, Montevideo
Pike & Cia., S A.
VENEZUELA, Caracas
Venairco, S. A.
VIRGIN ISLANDS, St. Thomas
Caribbean Corporation
YUGOSLAVIA, Belgrade
Tehnoservis

* Denotes Dealer.

The B&H **JETCAL**®

ANALYZER

now safeguards passenger jets

assures... maximum range
lower operating costs
increased safety
peace of mind... for crew and passengers!

TESTS EGT SYSTEM ACCURACY to ±4°C
(functionally, without running the engines).

RUNS TEMPERATURE SPREAD CHECK on TWO ENGINES at SAME TIME. CUTS TEST TIME 50%.

TESTS RPM ACCURACY to 10 RPM in 10,000 RPM (±0.1%).

CHECKS HEAT, ANTI-ICE and FIRE DETECTION SYSTEMS.

The JETCAL® is in worldwide use... by the U.S. Air Force and U.S. Navy as well as by major aircraft and engine manufacturers... and air lines. *Write, wire or phone (EDison 6-7243) for complete information.*

B & H INSTRUMENT CO., INC.

3479 West Vickery Blvd. • Fort Worth 7, Texas

SALES-ENGINEERING OFFICES:

COMPTON, CALIF.: 105 North Bradfield Avenue • NE 6-8970
VALLEY STREAM, L. I., N. Y.: 108 South Franklin Avenue • LO 1-9220
DAYTON, OHIO: 5606 Rice Place • BE 3-4411
CANADA: GEORGE KELK, LTD., 131 Willowdale Avenue, Toronto, Ontario
ENGLAND: BRYANS AEROQUIPMENT LIMITED, 15, Willow Lane, Mitcham Surrey *Exclusive Licensee and Manufacturer for Great Britain, British Commonwealth and Europe*

. . . so I looked her straight in the eye and said:

"With fuel temperatures approaching minus 50° Centigrade at today's operating altitudes the problem of pumpability is a factor to be reckoned with. But **AIR BP** have established positively that BP aviation fuels retain full fluidity when temperatures sink to even lower levels . . . . . "

You being personal, old man?

AIR BP

THE AVIATION SERVICE OF BRITISH PETROLEUM

RADAN 500 and TNC-50

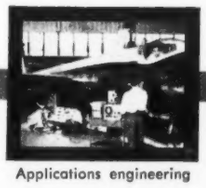
the perfect navigation team for commercial airlines

RADAN 500 Doppler radar and ***TNC-50*** Track Navigation Computer, GPL's new ARINC navigation system, provide airlines with a dramatic extension of present capabilities.

SELF-CONTAINED: Ground speed and drift angle, distance to destination and distance left or right of intended track are displayed directly, continuously, and accurately. Outputs are provided for flight directors, autopilots, repeater indicators and attachments.

SAVINGS: Over the oceans or poles, along new or established routes, night or day, good weather or bad, RADAN 500 and TNC-50 provide better block-to-block time, significant operational savings.

RELIABILITY: Thirteen years of direct Doppler experience, service feedback on more than 1,500 operational GPL Doppler systems, continuous product improvement programs, and the special requirements of airlines dictated RADAN 500 and TNC-50 design. The result: reliability, ease of maintenance, and maximum time between overhaul.


Applications engineering

Service facilities

Spares inventory

GPL | A GENERAL PRECISION COMPANY

GENERAL PRECISION LABORATORY INCORPORATED, Pleasantville, N. Y.

A Subsidiary of General Precision Equipment Corporation

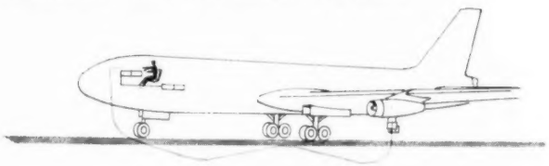
the world's longest screwdriver

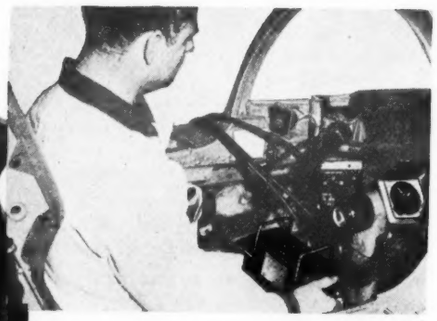
MOVES JET FUEL TRIMMING TO COCKPIT

Now only 1 man—instead of 3—trims fuel controls of all jet engines... faster... with greater accuracy... without hazard... all by remote control!

Eliminates exposure to dangerous noise and heat when trimming at the engine.

EXCLUSIVE **LEAR REMOTE CONTROL JET ENGINE FUEL TRIMMER SYSTEM**





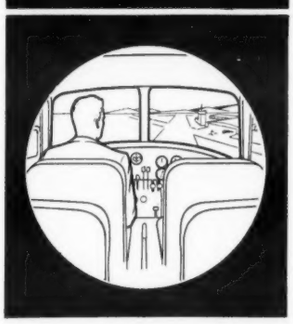
G-6

HOW IT WORKS.

In a matter of seconds, a servo-adapter combination is clamped directly to the fuel control on the engine to be adjusted. This servo-adapter is attached to a remote controller (usually in the cockpit) by means of an electrical cable. Thus one man can make all idle, military power and water injection adjustments.

LEAR

ELECTROMECHANICAL DIVISION
Specializing in actuating components and control systems – electro-mechanical, hydraulic, pneumatic
110 Ionia Ave. N. W.
Grand Rapids 2, Mich.



Aero Commander means business

Any way you look at it,
here is Leadership!

To you, Aero Commander leadership means going farther, faster and more easily. It means superior performance and dependability.

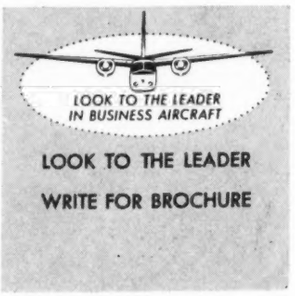
Aero Commander's high wing design is a factor of leadership: greater stability, more comfort. It means, too, that you step into this airplane as easily as you enter your car! You lift luggage just knee-high into the ample compartment. And there's panoramic visibility from inside the cabin.

Any way you look at it, this aircraft means business! Your distributor will show you more reasons for Aero Commander's leadership. Ask him, today.

AERO COMMANDER

Another product of ROCKWELL-STANDARD Corporation

AERO DESIGN & ENGINEERING CO • BETHANY, OKLAHOMA



LOOK TO THE LEADER

WRITE FOR BROCHURE

CONTINUOUS POWER* with the AIR PARTNER

*A VITAL FACTOR IN JET STARTS

A mobile unit for starting, air-conditioning, de-icing and testing the jet airliners of today

STARTING · AIR CONDITIONING · DE-ICING

The Air Partner is a surge-free rotary screw compressor of the Lysholm type designed for starting, air conditioning and de-icing all jet and turbo-prop airliners having air turbine starters.

A SUCCESSFUL COMBINATION

Atlas Copco, the world's largest organisation devoted exclusively to the manufacture of compressed air equipment, combined aeronautical expertise with compressor know-how to produce this multi-purpose unit.

STARTING

The Air Partner delivers a continuous flow of warm, oil-free air to turn the engine over constantly thus eliminating mis-starts.

AIR CONDITIONING

The Air Partner becomes an air conditioning unit by merely flicking the appropriate switches and pressing a button, a matter of seconds.

DE-ICING

A special mouthpiece attached to the air hose enables the wings and fuselage to be 'sprayed' with warm air. Removal of ice and sleet from windshields, wing leading edges, and air intake lips is achieved by using the ordinary de-icing outlets of the aircraft.

SIMPLE MAINTENANCE

The Air Partner has no wearing parts. It consists of two screw rotors which intermesh but never touch one another or the casing. 10,000 hours is the normal period between overhauls for screw compressors of this type.

Maintenance operations can be carried out by airline personnel anywhere in the world or through the Atlas Copco sales and service organisation established in 90 countries.

TWO MODELS

Air Partner M-3 consists of two identical units, each including a compressor connected to a standard petrol or diesel engine, for starting, air conditioning, de-icing and checking auxiliary systems.

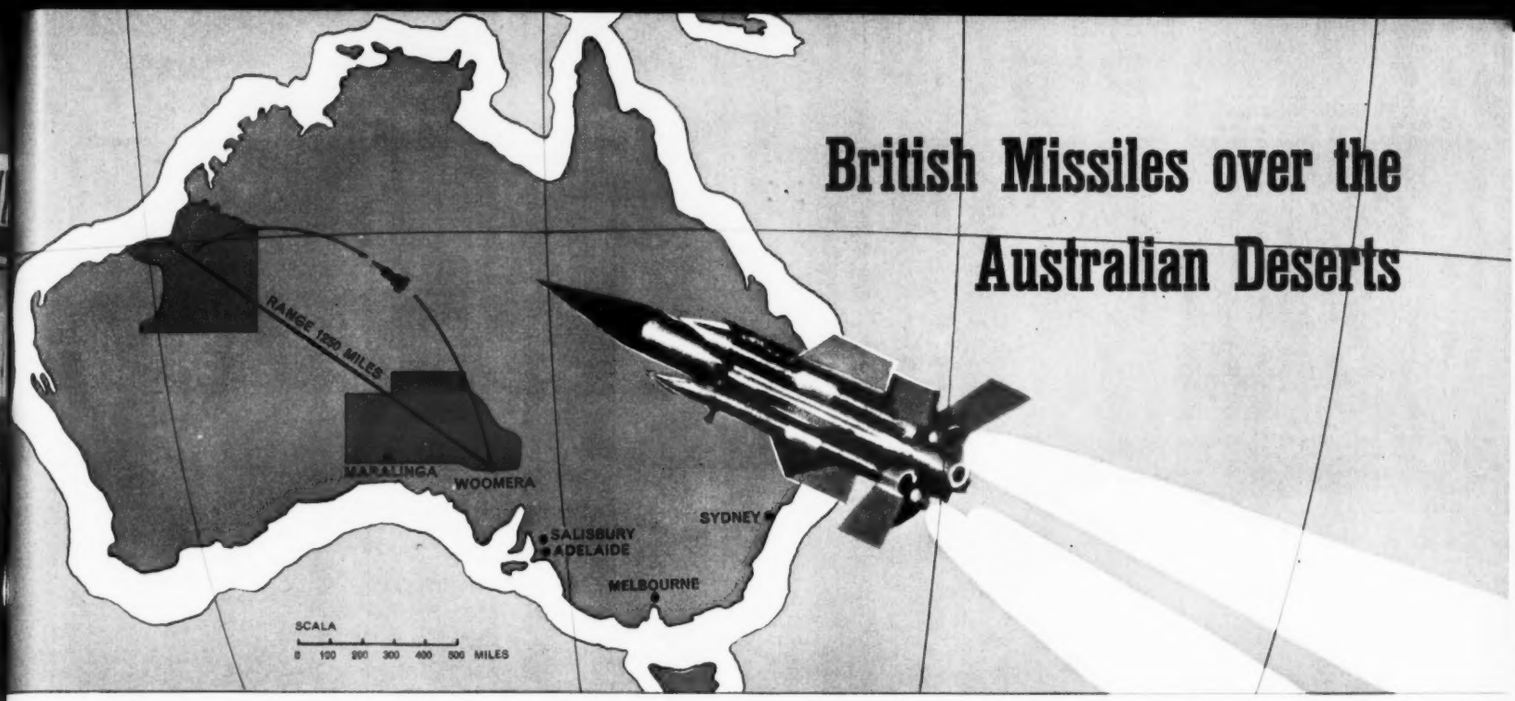
Air Partner M-2 consists of one rotary screw compressor connected to a standard petrol or diesel engine for starting and limited air conditioning.

THE *Atlas Copco* AIR PARTNER

A contribution to the jet age of air travel

Contact your local Atlas Copco company or agent or write to Atlas Copco AB, Stockholm 1, Sweden

British Missiles over the Australian Deserts



The shaded areas show the Woomera site which, covering a distance of 1,250 miles, is the largest overland range outside Russia.

The Weapons Research Establishment, Woomera

A great stretch of virtually uninhabited desert in the Southern Hemisphere has in the past ten years become one of the main proving grounds for the Western world in the rocket age.

Woomera, in Australia, practically unknown until 1948, is now a household word. Its importance in strategy will increase further as western Europe's first long range ballistic missile *Blue Streak* is prepared for firing, probably within 12 months, and the British Commonwealth space programme gets under way. Geographically speaking it is well situated and the atomic testing station at Maralinga is only 300 miles away to the west.

It is also likely that, since it is the only 1,250 mile *overland* range outside Russia, use may be made of Woomera's facilities by the United States. The advantages of isolation, security and weapon recovery on land are vitally important but, if necessary, the range can be extended a further 1,000 miles over the Indian Ocean, giving a total length of 2,250 miles.

When, in 1946, the U. K. began considering the whole subject of guided weapons it was realised that the British Isles were far from being ideal for actual firing trials, as sites were limited in size, weather was unreliable and all actual firings had to be performed out to sea with subsequent loss of the test vehicle. Accordingly a preliminary survey of a site at Woomera was made in 1946 by a group from the Ministry of Supply, the Armed Services, and the Australian Government.

Having determined the site, a board of administration was set up and responsibilities divided between the U. K. and Australian Governments according to resources. Basically, the U. K. with its highly developed industrial and research system designed and built the weapons, while Australia provided the range and equipment for analysing resultant data.

Although the arrangements were only put in hand in 1947, test vehicles were being fired from the range within a year. Despite the fact that the two countries are some 11,000 miles apart the arrangements have worked exceptionally well, and Woomera has seen all the major British weapons projects through their test-firing and service trials programmes.

From a few huts and small beginnings, the Weapons Research Establishment Woomera has grown to a staff of around 3,000, with a complete township of over 500 bungalows with modern amenities.

Detailed laboratory work and trials planning are carried out at Salisbury near Adelaide, where an explosives factory has been taken over. Salisbury now possesses exceptional facilities covering a variety of computers, a highly developed data reduction system using the Elliott WREDAC digital computer, optical and radio observing apparatus including space research equipment, laboratories for electronics, propulsion and aerodynamic research, and supersonic wind tunnels. Big advances have also been made on free flight trial of weapon and aircraft shapes using models attached to rocket boosters.

Extensive operational flying is done from Evatts Field, Woomera, with *Jindivik*, *Meteor* and *Canberra* pilotless targets and a number of fighters and bombers carrying test air-to-air and air-to-ground weapons. Australia is now developing a supersonic version of the *Jindivik* which is badly needed on the ranges.

RAAF freight and passenger air services shuttle between Edinburgh airfield, Salisbury, and the Woomera fields, 350 miles north west, while into Edinburgh come RAF Comets, and Hastings. Air Charter Super Traders (Tudors) carry essential personnel, weapons and equipment from Britain to Adelaide. Road and rail facilities are also available between Woomera and Salisbury and TAA run a daily service Woomera–Adelaide.

Communications have always been a problem, but the two-way transmission of reports, requests and data has become almost as speedy as between a factory and its test range in the U. K. itself. Weapons go by sea or air according to programme and urgency, while modification kits, instruments and spares are invariably airlifted.

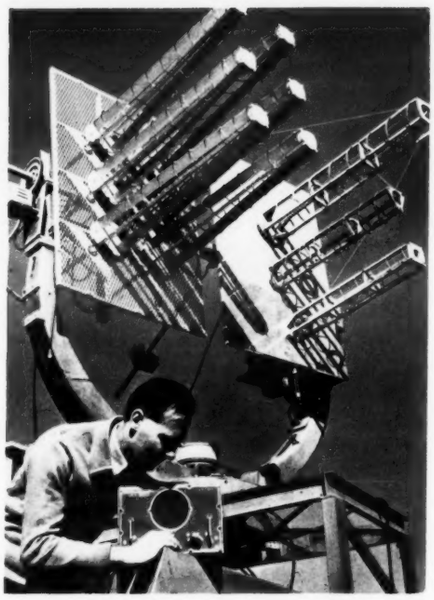
With the advent of larger test rockets such as *Black Knight* and LRBM's in the shape of *Blue Streak*, it is

This bank of Thunderbird *rounds without boosters is ready for despatch from the Salisbury depot.*

A battery of Bloodhounds *prepared for firing on the Woomera range.* (Crown Copyright Reserved).

This Series 3 launcher is erected on Range E at Woomera.

A test vehicle for the Bristol Thor *ramjet engine with 4 solid propellant boosters.*



Radar aerial equipment used to plot the course of the Jindivik *target plane.*

The Thunderbird *is mounted on the elevating frame and is being run down the rails on to the launcher. A turntable on the loading trailer can be rotated through 90° to allow the folding rails to be mated with channels in the launcher base.*

The Jindivik, *Australia's pilotless target aircraft, can operate at heights in excess of 50,000 ft. The wing tip pods contain cameras which record the miss distance of weapons fired against it.*

clear that much larger rear opening long range freighters are urgently needed. The Lockheed *Hercules* of the RAAF will do much to fill the gap, but ultimately the heaviest loads will devolve upon the four-*Tyne* Short *Britannic*.

As the British weapons programme worked its arduous way from basic control, launch, power plant and systems test vehicles towards actual weapons, it became clear that the companies involved must participate at Woomera itself in addition to the Government and service scientists. Units began to form in size in 1952—53 to supervise and assist in every phase of testing their particular product, and individual firms have had over 100 technicians at WRE at one time or another.

Woomera is now entering upon its third major phase as a test base. Initially it sorted out basic problems so that weapons could be built, and secondly it tested to operational status the first generation of British missiles. Now, the more sophisticated versions of standard weapons are at the early trials stage and new types have appeared, such as the *Blue Steel* stand-off bomb.

Weapon development and the ability to improve generation by generation can come only from long and sometimes heartbreaking effort and experience, and it is 10 years of this that is being fed back into Britain's new weapons and into such items as *Blue Streak*.

Woomera has now taken to service acceptance stage three ground-to-air weapons systems, the Bristol/Ferranti *Bloodhound* for the RAF, the English Electric *Thunderbird* for the Army and the Armstrong Whitworth/Sperry/GEC *Seaslug* for the Royal Navy.

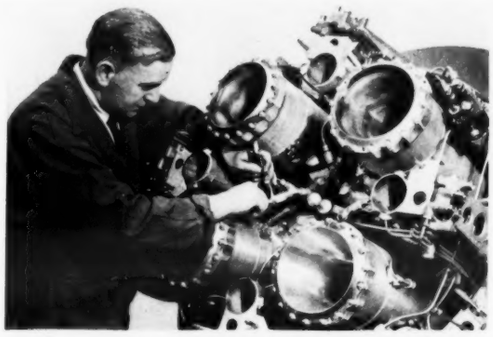
It has been announced that stage 2 developments of *Bloodhound* and *Thunderbird* are being actively developed, and it is logical to assume that the same applies to *Seaslug*. It is likely that this "Stage Two" may take advantage of the improvements in high power continuous wave radar.

In the air-to-air field the first weapon which completed its RAF acceptance trials was the Fairey *Fireflash*, until recently the operational training weapon of the service. Following this has come the de Havilland *Firestreak* with its infra-red heat homing head and automatic infra-red miss-distance fuse. *Firestreak* has been fired in considerable numbers at Woomera and is now in service with the RAF. Later it will also go to the Royal Navy as standard equipment.

Static Tests of Blue Streak at Hatfield

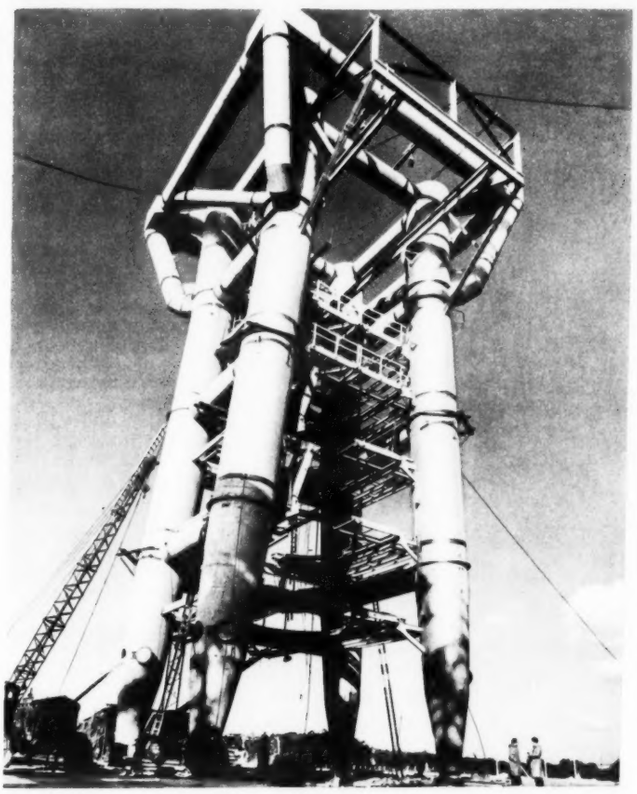
Further development of the *Blue Streak* LRBM is continuing at the de Havilland laboratories, Hatfield, concurrently with preparations for launching tests of the first prototype on the Woomera range. Rolls Royce are producing the main booster which, it is understood, will be manufactured to a large extent under a Rocketdyne licence. Trials of the Rolls Royce power unit began late last year on a test rig at Spadeadam Waste, Cumberland.

Sperry have developed the guidance system, and the nose cone and other equipment are being tested on the Saunders Roe *Black Knight* research vehicle which was successfully fired, at the third attempt, on June 11th, 1959. The photograph of the static test facility, which has recently been erected for trials of the missile body and systems, emphasizes the active research which de Havilland Propellers Ltd. and their subcontractors have undertaken to enable *Blue Streak* to be flight tested in 1960.

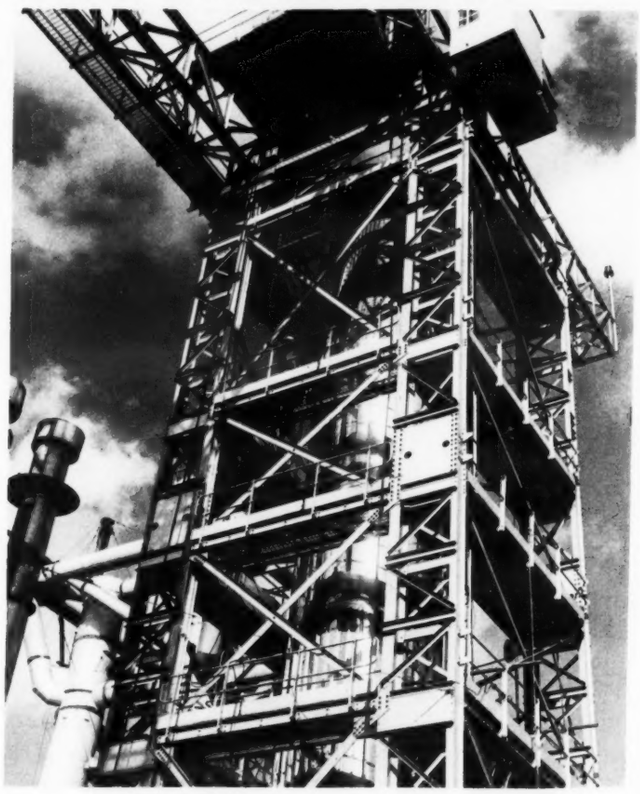


The four-chamber Armstrong Siddeley *Gamma* rocket engine is used on the *Black Knight* research missile which was fired to a height of about 500 miles on June 11th, 1959 at the third attempt.

The test rig for the *Blue Streak* LRBM is made of welded steel tubing of more than 6 ft. diameter.



The large test tower for the *Blue Streak* at the de Havilland works, Hatfield. A prototype *Blue Streak*, 60 ft. high, can be seen mounted in the tower.



In this field too, it has been revealed that a later development of *Firestreak* is now on test, presumably with higher speed, discrimination and lethality.

Trials are well advanced at Woomera on the *Blue Steel* stand-off bomb which is to equip the *Victor 2* and *Vulcan 2* of Bomber Command. With Doppler/inertial guidance and a range of several hundred miles, *Blue Steel* is a very flexible and deadly hydrogen warhead weapon, which may also lend itself to adaptation as an earth satellite/re-entry test vehicle air launched from about 35,000 ft.

Normally anti-tank weapons can be tested on small army weapon ranges, such as Larkhill, but Woomera has in fact been used for the *Malkara*, a weapon which bears the distinction of being an all-Australian missile exported to the United Kingdom. Now on evaluation by the British Army, *Malkara* is wire wound with a range of 2,000 yards, a weight of about 200 lb. and is transportable by two men.

Woomera has already made significant contributions to ballistic weaponry and to space research. In support of the International Geophysical Year a number of *Skylark* research rockets were fired, and more went up under the programme arranged by the Gassiot Committee of the Royal Society.

In addition the "rockoon" device *Harp* has been fired from balloons to heights of about 60 miles. Two firings of the *Gamma*-engined *Black Knight* re-entry test vehicle have so far been announced, and several more will be launched. Due to its simplicity and low weight the *Black Knight* was immediately proved successful when it left the earth's atmosphere for the first time in September 1958.

More ballistic type missiles will reach the Woomera firing stage when the full scale model of the still secret British Army ground-to-ground weapon to replace *Corporal* is ready in the "not-too-distant future".

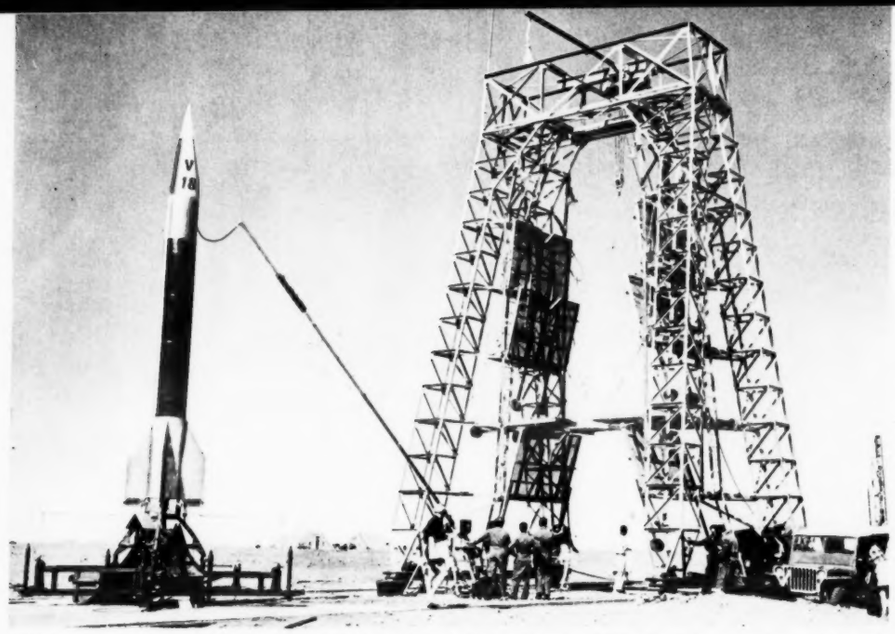
Scientists in the U. K. and in Australia are now awaiting the outcome of discussions on the British space programme and of Professor Massey's visit to the USA. Initial British satellite equipment may be carried on American rockets, but it is almost certain that *Blue Streak* will eventually figure in the experiments.

Obviously the military test side of the *Blue Streak* programme has top priority, but a great deal of useful data for space work will be gained from these firings which should commence next year.

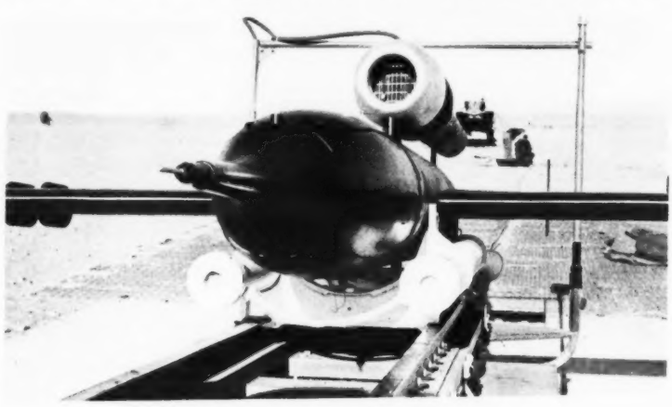
At present a combination of *Blue Streak*, developed *Black Knight* and a third booster stage is being considered for getting a 1,000 lb. satellite to a height of a few hundred miles.

Another proposal is for *Blue Streak* combined with an "optimum" second stage which, it is calculated, could take a 1,000 lb. satellite up 22,000 miles or a 1 ton satellite 300 miles.

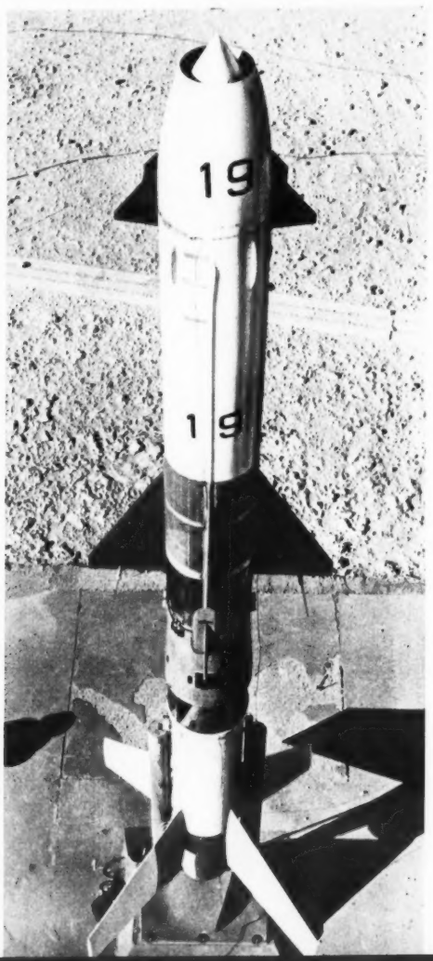
Whatever is finally prepared for space, it is certain that Woomera will continue to hold its pre-eminent position as a firing range.



A Véronique *experimental rocket shortly before being launched to an altitude of 155 miles. The maintenance rig has already been moved aside, and in a few minutes the ignition signal will be given to the missile on the launching pad, via the connecting cable.*



The Nord CT.10 ramjet-powered subsonic target drone is still giving valuable service in the testing of new air-to-air and surface-to-air weapons. Derived from the German wartime V 1 and launched from a ramp by means of two boosters, the CT.10 operates at altitudes of up to 15,000 ft. Endurance is roughly 35 minutes, range of the radio command guidance system on the ground roughly 30 miles.



The ramjet-powered MATRA 431 surface-to-air missile on the launching pad at Hamma Guir. The solid-propellant booster accelerates the missile to Mach 1.8, whereupon an integral ramjet engine, designed by Nord-Aviation, carries it up to Mach 2.7 and enables it to operate at altitudes of up to 12 miles. Range 50 miles; weight roughly 1 ton.

Ballistic Missiles

Missile Testing

By a strange paradox quite in keeping with the modern age, the skill of man has been at its most fruitful in finding new uses for the most barren regions of the earth. For their tests on missiles, the ultimate achievement of modern scientific research, the great nations are eagerly seeking out vast spaces, sterile and empty since the dawn of the world: the wastes of New Mexico, the Australian desert, and finally the Sahara. For deserts are easier to equip and utilize than oceans, and it is easier to find the capsule of a *Discoverer* in the sands than amidst the Atlantic waves.

France will in future be able to offer Europe a missile range unique in the whole world. The distance between Colomb Béchar and Bilma is 1,250 miles, between Biskra and Podor 1,875 miles. And the Sahara, a desert which is, so to speak, "civilized" and crossed by a large number of tracks, combines the advantages of isolation with those of industrial development.

It was these considerations which, as early as 1946, prompted the French Ministry of National Defence to set up the inter-forces missile test centre (Centre Interarmées d'Essais d'Engins Spéciaux = CIEES) at Colomb Béchar under the command of Colonel Arsac of the Air Force. Colomb Béchar is particularly suitable for this purpose, since it is linked with the Mediterranean coast by two railways and is near the Kenadza mining district which will be a future source of power.

In spite of its slow development in the lean post-war years, CIEES has now become, thanks to close collaboration between the French Army and Air Force, a powerful research and experimental organization offering unique facilities to military departments and civilian concerns. It is now under the direction of General Aubinière, air ace and graduate of the Ecole Polytechnique who, before brilliantly directing the Air Force specialist training centre at Rochefort, was second in command at the School of Aviation. General Aubinière combines great knowledge with wide experience, and in continuing the work of his predecessors, Colonels Arsac, Michaud and Heriard-Dubreuil, he has succeeded, despite current difficulties, in "keeping the wheels turning" at Colomb Béchar to the satisfaction of all.

CIEES comprises basically;

- A methods department responsible for all organizational measures.
- Two large sub-divisions, the technical tests section (directed by Chief Engineer de Coligny) and the tactical trials section. Each of these is divided into two subsections: "Army" and "Air Force" (*).

Technically, the Air Force sub-section is responsible to the Technical and Industrial Directorate (Engineer

(*) The Navy's representatives at Colomb Béchar are primarily observers.

Nord CT.20 target drone (equipped with Turboméca Marboré *jet) on the launching ramp at Colomb Béchar. The vehicle weighs 880 lb., has a speed of Mach 0.85 and an endurance of 50 minutes. At the present time Nord-Aviation is working on the CT.41 supersonic drone, with two ramjets and a weight of 3,000 lb; design speed Mach 2.3.*

in the Sahara

General Bonte) and operates in conjunction with the flight test centre at Brétigny. The Army sub-section is responsible to the Directorate of Armaments Research and Production and the Army Technical Department. Tactically, the Air Force sub-section is attached to the Mont de Marsan training centre, the Army sub-section being divided into two guided weapons units, the 701st, which handles surface-to-air missiles, and the 702nd, which is responsible for surface-to-surface weapons.

The methods department deals with the operation of the missiles and supplies radars, cine theodolites, computers, photographic equipment, target drones, the remote-controlled *Vampire*. the interception cells and the entire track plotting system (plotting tables etc.). In short, the methods department constitutes a fully automatic air defence unit and in this sense gives a foretaste of things to come.

At Colomb Béchar itself, CIEES forms part of a larger organization, namely, the Air Base. As a result of current operations the base has become highly important, with its transport unit and its squadrons of light aircraft and helicopters, and employs no fewer than 5,000 men.

But the real *raison d'être* of Colomb Béchar, the Hamma Guir missile range, lies more than 60 miles south-west in the midst of the desert, in the rocky bed of Wadi Guir (a tributary of the Saoura, which trickles away into the sands of the Grand Erg). Here about 1,000 personnel work at a model base where the conditions, once monastic, are now ideal; there is air conditioning and a swimming-pool, as well as a series of launching ramps at which technicians can be seen at work.

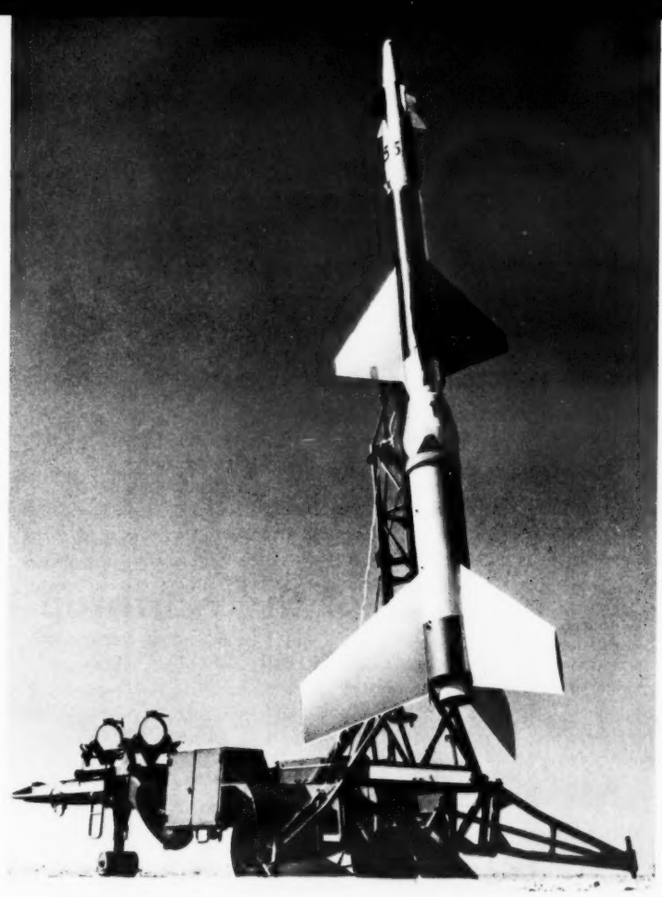
There is considerable activity at Hamma Guir, where the Air Force is at present testing its Nord 5103 and Matra 511 air-to-air missiles and their air-to-surface versions, and surface-to-air missiles such as the Matra 431 for the interception of high-altitude supersonic bombers. In passing, mention should be made of the remarkable results recently obtained with the Matra 422 and the spectacular launching of the SE. 4200 surface-to-surface weapons.

The Army is at present training units in the use of the *Parca* guidance system and short-range surface-to-surface missiles.

In 1958 a total of over 800 missiles were launched at Colomb Béchar by military authorities and civilian organizations. Various military missions from abroad had the chance to visit the installations.

A technical "hotel with all modern conveniences" for men and machinery, Colomb Béchar is fully prepared for future tests on IRBMs, satellites and space vehicles. While, as in the past, camel caravans wind their way intrepidly across the desert, buildings rise, machines multiply and engineers flock in.

France has created a valuable proving ground, and she will not hesitate to make full use of it.

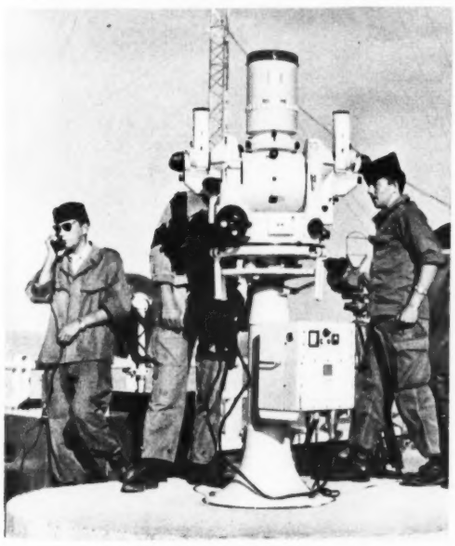


The MATRA 422 two-stage anti-aircraft missile on a mobile launching pad. Designed for the interception of transonic bombers at high altitudes, the weapon is powered by SEPR solid-propellant motor and has a range of roughly 30 miles. Overall weight is 1,320 lb. (apparently without booster), and a 220 lb. warhead can be carried to altitudes of up to 60,000 ft. (cf. Interavia *No. 6, 1959, p. 711).*

On the periphery of the rocket proving ground: the tumble-down mud huts of Old Colomb Béchar, half washed away by the occasional rains. The high tension cables in the foreground and the modern buildings in the rear stand out in strange contrast to the derelict Arab settlement.

Night firing of two Sud Aviation SE.4200 tactical surface-to-surface weapons. The path of the two missiles is marked by a triple light trace up to the moment of burnout of the solid-propellant booster, followed by a single trace from the long-burning ramjets.

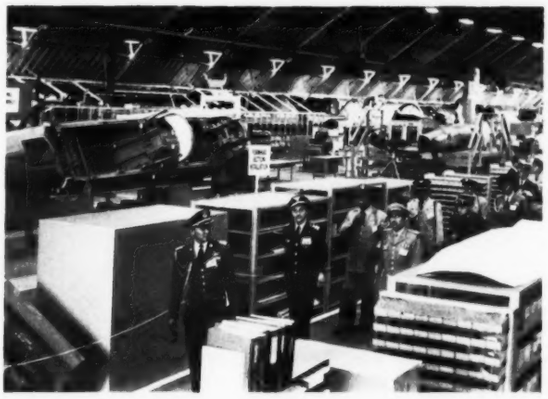
Cine-theodolite of the 701st Missile Group at the anti-aircraft rocket test centre, near Colomb Béchar. The theodolite, set up near the launching ramp, records the ascent of anti-aircraft missiles and is a valuable aid in the measurement of missile trajectories.



Over 50 military attachés from all over the world attended the celebrations marking the completion of the first Northrop N-156F supersonic fighter.

Roll-Out of the Northrop N-156F Multipurpose Fighter

A great day for Northrop: Thomas V. Jones, President of the Northrop Corporation, welcoming guests at the "roll-out" ceremony and re-outlining his programme for the multipurpose fighter, destined for the export market.



At Northrop's Hawthorne plant guests are shown the T-38 supersonic trainer, production of which is now under way. The prototype has so far made over twenty-four successful supersonic trial flights from Edwards Air Force Base.

The experts agree . . . Armed with air-to-air missiles, the N-156F will have a takeoff weight of 15,000 lb.; the fighter-bomber ground support version will weigh 16,230 lb. with external loads.

Aero Commander and Gulfstream

Two Typical American Business Aircraft

Large companies in both the Old and the New World have long appreciated how much time can be saved by making their top management airborne. Dozens of firms use business aircraft in every European industrial country. But this is nothing compared with the swarms of business aircraft in the skies of America.

According to the Air Transport Association of America ("Air Transport Facts and Figures" 1959), there were all in all 1,902 airliners in service in the United States at the end of 1958. At this time, however, figures published by the National Business Aircraft Association at the end of May 1959 reveal that some 24,000 aircraft were in use by industrial and trade corporations for the transport of passengers and goods. To avoid errors, it should be stressed that these figures do not include the aircraft used by agricultural undertakings, flying schools or air taxi operators. If all the civil aircraft flown in the United States by operators other than the airlines were counted, the total would reach the impressive figure of 70,000. The upward surge in this field during the past twelve years has been a steep one: one year after World War II there were only 2,500 business aircraft registered in the United States all told.

Today's 24,000 business aircraft certainly do not let the grass grow under their feet. In 1958 business aircraft logged 5,300,000 hours in the air, while the combined fleets of all the scheduled airlines recorded a total of only 3,800,000 flying hours.

It will therefore come as no surprise that this dense flying activity should present the aviation authorities with some thorny problems. The number of airports available causes no concern, since the above-mentioned National Business Aircraft Association reports that American aircraft can use 7,000 airfields, only 550 of which must be shared with the airlines. A more serious question is how to organize operations on the already overcrowded airways if the number of business aircraft in service continues to grow at its present pace. An interesting pointer here is the fact that business flying was recently recognized by the Federal Aviation Agency as an independent branch of civil aviation. The FAA has divided its civil aviation department into four sections: air transportation, business flying, general civil flying and international operations.

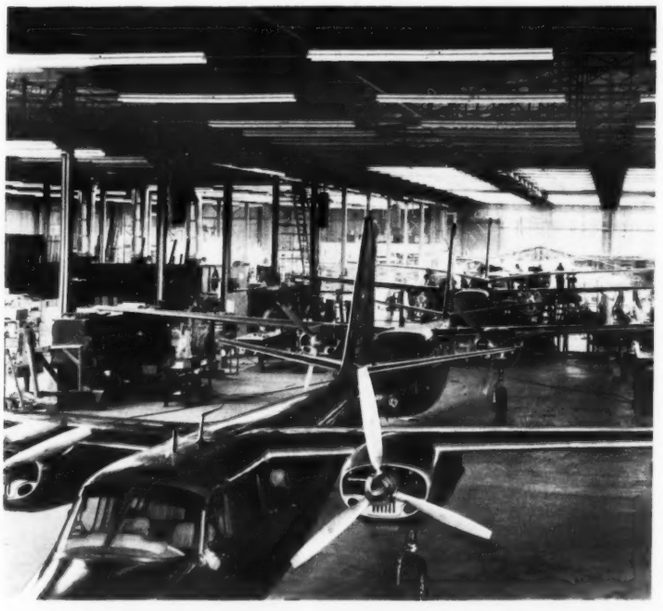
Meanwhile the annual report of the Aerospace Industries Association ("Aviation Facts and Figures" 1959) announces that almost all multi-engine and more than half the single-engine utility aircraft in service are now equipped for all-weather flying.

*

The aircraft manufacturers are successfully keeping pace with the development of business flying, both qualitatively and quantitatively. While 1958 brought a fall in sales to many branches of American industry, deliveries of business aircraft rose from 6,120 the previous year to 6,416, valued at roughly $135 million ($10 million more than in 1957).

Two typical examples of all-weather twin-engine business aircraft have been selected for description below, one of them a *six-seater with piston engines*, and the other a *twelve-seater with propeller turbines*. The first costs $100,000 to $150,000, depending on the equipment fitted, and is thus within the reach of smaller companies. The price of the second, on the other hand, is roughly one million dollars, including equipment, and will thus normally be considered only by the larger organizations whose turnover runs into eight or nine figures. However, the fact must not be overlooked that there are already some 1,000 large multi-engine business aircraft of the airliner category in service in the United States and that many of these will soon need replacing.

Several hundred 6-to-7-seat *Aero Commander* executive transports (with piston engines) have been produced by Aero Design & Engineering Company, of Bethany, Oklahoma, during the past eight years and sold throughout the world, as well as to the U.S. forces.



By contrast the 12-seat Grumman *Gulfstream* (with propeller turbines) has only recently gone into production, though Grumman Aircraft Engineering Corporation, of Bethpage, Long Island, N.Y., has already received orders for a total of 40 of these aircraft.

Aero Design Commander

The prototype of the *Aero Commander* made its first flight on April 23rd, 1948 (upper picture). Since then five civil and three military versions have been derived from the original model, including the model 720 *Alti-Cruiser*, with pressure cabin, shown in the lower picture.

The U.S. Army's *Aero Commander 680* (L-26C) communications aircraft. Special three-seat versions (RL-26D) are equipped with 21-inch weather radar in the nose and approx. 20-foot "side-looking" radar on either side of the fuselage. These are used by the Army as all-weather combat zone reconnaissance aircraft.

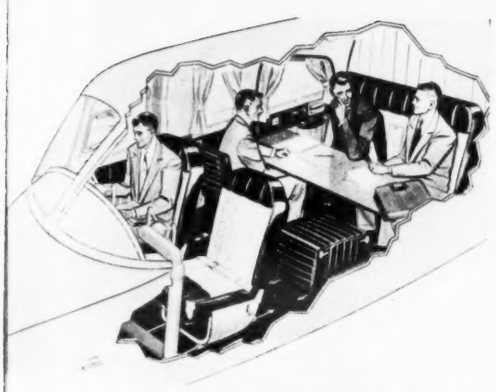
The twin-engine, five-to-seven-seat *Aero Commander* has an almost 14-year development history behind it and can therefore almost be classed among the "old guard" of American business aircraft. Design work began in December 1945, the first flight took place in April 1948, CAA certification was obtained for the prototype in June 1950 and for the first production model in January 1952. Since then the manufacturers, *Aero Design & Engineering Company*, of Bethany, Oklahoma (today a subsidiary of Rockwell-Standard Corporation), have kept the basic design up to date by constant improvements to the airframe and its equipment, and the *Lycoming Division of Avco Corporation* has supplied increasingly powerful and reliable engines.

Whereas the 1948 prototype, with 190 h.p. Lycoming engines, had a gross weight of 4,400 lb. and a top speed of 180 m.p.h., the latest model (680E), with 340 h.p. Lycoming GSO-480 geared, supercharged engine, reaches a sea level maximum speed of 255 m.p.h. for a gross weight increased to 7,500 lb. An aircraft of this latest model, piloted by Miss Jerrie Cobb, set up a new international speed record of its class over a 2,000 km distance in April 1959.

At the present time the *Commander* is being built in *three civil versions* (see table), plus two civil and one military sub-versions. These differ from one another not only in technical details, but also quite considerably in basic price. The three main series covered by the table fall into the following individual models:

- *680 Super* (military designation L-26C), predecessor of the 680E with the same powerplant, but slightly smaller span (44 ft.) and lower gross weight (7,000 lb.). Two aircraft of this model form part of the White House fleet in Washington, D.C.
- *720 Alti-Cruiser*, pressurized version of the 680E. Can be equipped as a four-seater on request, with the extra space taken up by a washroom and toilet.
- *RL-26D*, three-seat military reconnaissance version of the *680 Super*, with weather radar in the nose and two 18-foot "sidelooking" radar antennas, one on either side of the fuselage; some aircraft also have photographic equipment. Complete all-weather instrumentation and autopilot.

All the series of this all-metal high-wing model have the same twin-spar, one-piece wing of high aspect ratio (9.6) and a fuselage of semi-monocoque construction. The cabin, with a total volume of 177 cu.ft., is reached via a large door, opening backwards, in the port wall. In the 720 *Alti-Cruiser* the cabin is pressurized, for which purpose use is made of a 20 h.p. hydrau-



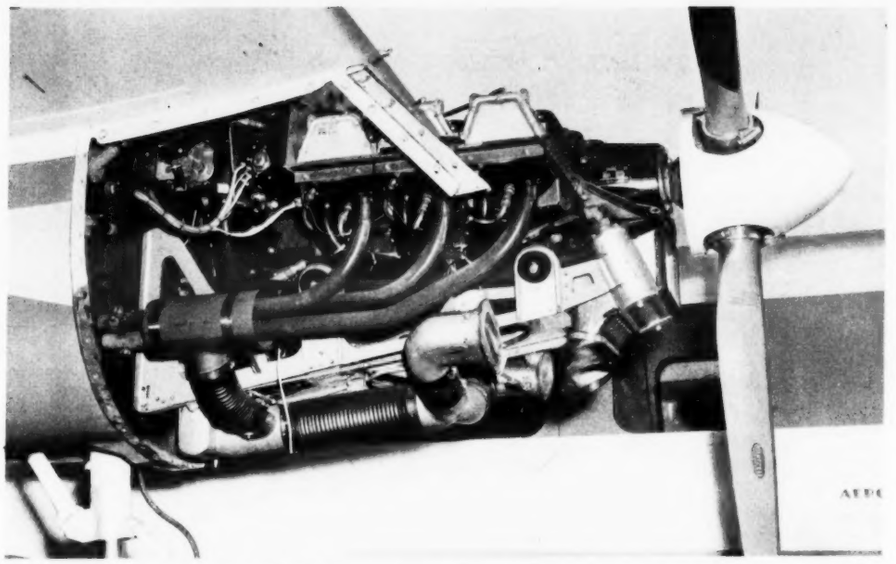
Seating arrangement for the 7-seat version of an *Aero Commander* with collapsible conference table. In the ordinary way, however, six individual seats are fitted, all facing forwards.

lically operated centrifugal compressor supplied by the Stratos Division of Fairchild and of engine-driven hydraulic pumps (in both nacelles). At a flying altitude of 15,000 ft., cabin pressure corresponds to 8,500 ft. A 32 cu.ft. baggage area is reached from the outside via a cargo door behind the cabin door. Landing flap operation and undercarriage retraction are hydraulic.

The standard equipment includes the usual items plus one or two gyro horizons and gyro compasses, dual controls and thermostatically controlled heating. The following can also be installed, at extra charge: VHF communication and navigation equipment, ADF, autopilot, oxygen equipment, de-icing equipment, rotating flashing light, additional cabin fitments.

Yet another interesting point is that the *Commanders* sold to European customers are regularly flown across the Atlantic. Early in June 1959, for example, Miss Jerrie Cobb with Jim Watson (Aero Design Service Manager) as co-pilot flew a *Commander* from Boston, Massachusetts to Torbay, Newfoundland and thence over a 1,425 mile stretch of water to Lajes, Azores, and finally to Lisbon and Paris, for the 23rd Air Show.

Miss Jerrie Cobb, holder of a number of international speed and altitude records, steps out of her *Commander 560E* after an 8½-hour non-stop flight (1,520 miles) from La Aurora, Guatemala to Oklahoma City, USA.



Two six-cylinder Lycoming GSO-480-B1A6 opposed-type engines (with reduction gear and supercharger) with three-blade Hartzell constant speed metal propellers form the powerplant for the *Aero Commander 680E*.

The instrument panel of a civil *Aero Commander 680E*. An oxygen regulator is mounted on the right-hand cabin wall.

Characteristic Data and Performance for the Three Main Civil Versions of the Aero Commander

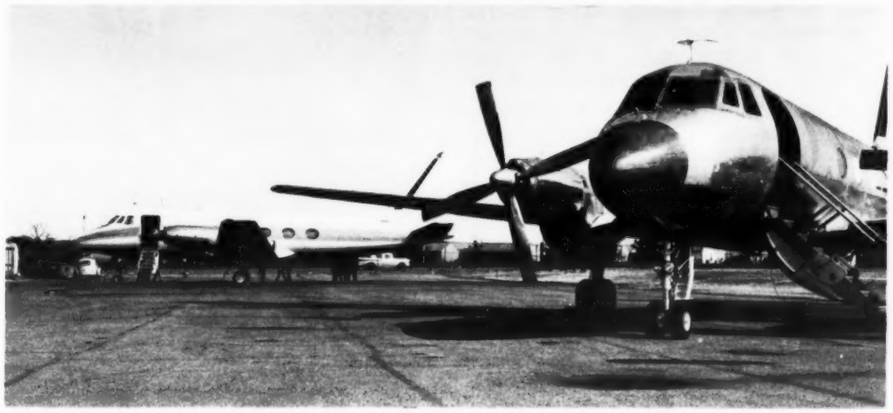
Works designation	500	560E	680E
Engines	Lycoming O-540-A2B	Lycoming GO-480-C1B6	Lycoming GSO-480-B1A6
Propellers	Hartzell 2-blade	Hartzell 3-blade	Hartzell 3-blade
Take-off rating	2 × 250 h.p.	2 × 295 h.p.	2 × 340 h.p.
Span	49 ft. 6 ins.	49 ft. 6 ins.	49 ft. 6 ins.
Wing area	255 sq. ft.	255 sq. ft.	255 sq. ft.
Max gross weight	6 000 lb.	6,500 lb.	7,500 lb.
Weight equipped, with standard equipment	3,900 lb.	4,300 lb.	4,475 lb.
Fuel capacity	156 U.S. gal.	223 U.S. gal.	223 U.S. gal.
Max. speed, sea level	218 m.p.h.	222 m.p.h.	255 m.p.h.
Cruising speed at 10,000 ft. 70% power	205 m.p.h.	212 m.p.h.	226 m.p.h.
Stalling speed, sea level, idling	68 m.p.h.	74 m.p.h.	79 m.p.h.
Ditto, with flaps and undercarriage down	63 m.p.h.	66 m.p.h.	71 m.p.h.
Service ceiling, 2 engines	21,400 ft.	22,500 ft.	25,400 ft.
Service ceiling, 1 engine	8,000 ft.	8,000 ft.	14,300 ft.
Sea level rate of climb	1,400 f.p.m.	1,450 f.p.m.	1,525 f.p.m.
Range with 55% power at 10,000 ft., with reserves for 30 mins.	1,100 miles	1,625 miles	1,400 miles

Grumman Gulfstream

The second American business aircraft selected for discussion, the Grumman *Gulfstream* (two Rolls-Royce *Dart 529* turboprops), is almost the same size as a DC-3, but has a considerably higher gross weight. Normally equipped for two pilots and ten passengers, the cabin, which is 32 ft. 8 ins. long and 73 ins. high, can be converted to take up to 19 passengers. Both cabin and baggage area are pressurized, to provide a cabin pressure altitude corresponding to 5,500 ft. at flying altitudes of 25,000 ft. Other characteristic data, weights and performance figures are listed in the following table:

Engines	Rolls-Royce RDa. 7/2 *Dart 529*
Propellers	Rotol four-blade
Take-off rating (at 15,000 r.p.m.)	2 × 2,105 e.h.p. (or 2 × 1,910 s.h.p. plus thrust)
Span	78 ft. 6 ins.
Length	64 ft.
Height	22 ft. 9 ins.
Wing area	not known
Max. gross weight	33,600 lb.
Normal gross weight	32,500 lb.
Weight equipped, incl. 12 passenger seats and 730 lb. radio and navigation equipment and autopilot	20,430 lb.
Crew (2), residual fuel, oil, injection water	750 lb.
Passengers (12) and baggage (12 × 40 lb.)	2,520 lb.
Zero fuel gross weight	23,700 lb.
Normal fuel and reserves	8,800 lb.
Max. fuel capacity (1,540 gal.)	10,400 lb.
Normal landing weight	30,900 lb.
Max. cruising speed at 25,000 ft.	310 kts
Stalling speed, sea level, at landing weight (idling)	70 kts
Service ceiling, 2 engines	35,800 ft.
Ceiling, 1 engine	20,000 ft.
Sea level rate of climb	2,290 f.p.m.
Range at 307 kts speed, at 25,000 ft., with reserves for 30 mins stacking plus 5% for extra consumption	1,910 n.m.
Range at 250 kts and 30,000 ft., reserves as above	2,265 n.m.
CAR take-off field length (ref. SR. 422A 4T) at normal gross weight, sea level, ISA	3,900 ft.
CAR landing field length (ref. SR. 422A 40T), at normal gross weight, sea level, ISA	3,820 ft.

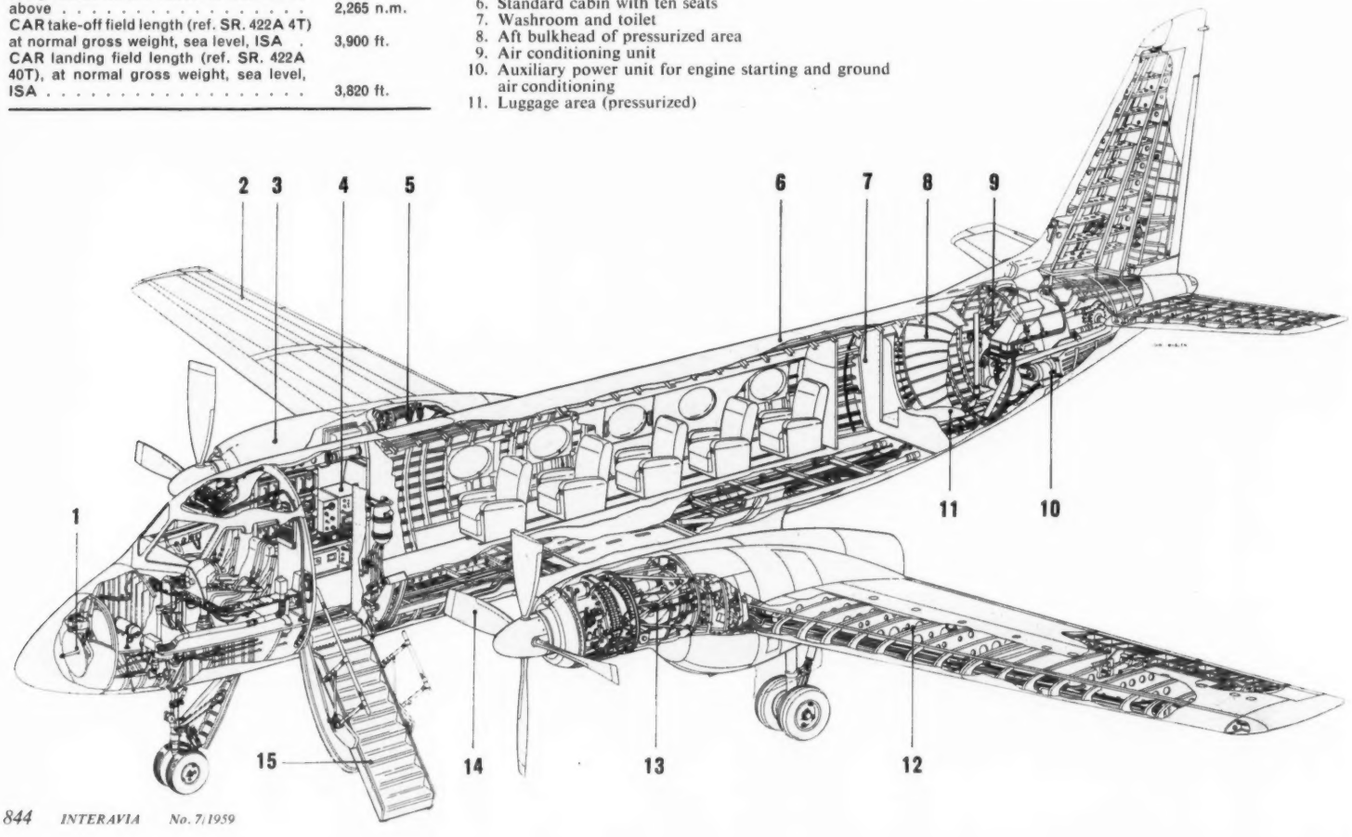
Prototype (works No. 1) of the Grumman *Gulfsteam* (two Rolls-Royce *Dart RDa.* 7/2 propeller turbines) over Long Island. Note the two air intakes for the air conditioning system (in the fin root) and the exhaust pipe for the auxiliary power unit used for starting and air conditioning on the ground (in the floor of the fuselage rear).



Works Nos. 2 and 3 (the latter with airborne radar) at Grumman's Bethpage airfield, Long Island, N.Y.

Structure of the twin-turboprop Grumman Gulfstream executive transport

1. Radar
2. Spring tab controlled (starboard) aileron
3. Quick opening nacelle panels
4. Radio, coat space, galley
5. Pressurization system
6. Standard cabin with ten seats
7. Washroom and toilet
8. Aft bulkhead of pressurized area
9. Air conditioning unit
10. Auxiliary power unit for engine starting and ground air conditioning
11. Luggage area (pressurized)
12. Wing centre section (and integral fuel tank)
13. Rolls-Royce *Dart RDa.* 7/2 propeller turbine
14. Rotol v.p. propeller
15. Built-in hydraulically-operated stairs



The first *Gulfstream* made its maiden flight on August 14th, 1958. Since then two more prototypes have been completed, and several hundred hours of flight testing carried out. Production is continuing at the rate of three aircraft per month so that by the end of the year a total of 27 *Gulfstreams* will have been manufactured. So far, orders have been received for 40 aircraft, though the manufacturers hope to be able to sell a number to the armed services, which could use them as VIP transports, navigation trainers, reconnaissance aircraft and electronic countermeasure aircraft.

The cantilever, three-part *all-metal wing* in the *Gulfstream* is composed of milled (upper and lower) light metal plates, with two spars and numerous ribs, and at the same time forms the integral main fuel tanks. The water-methanol mixture for take-off and climb at full power, however, is carried in flexible tanks in the outer wings. The wings also have large Fowler flaps and spring-tab operated ailerons. They are de-iced pneumatically.

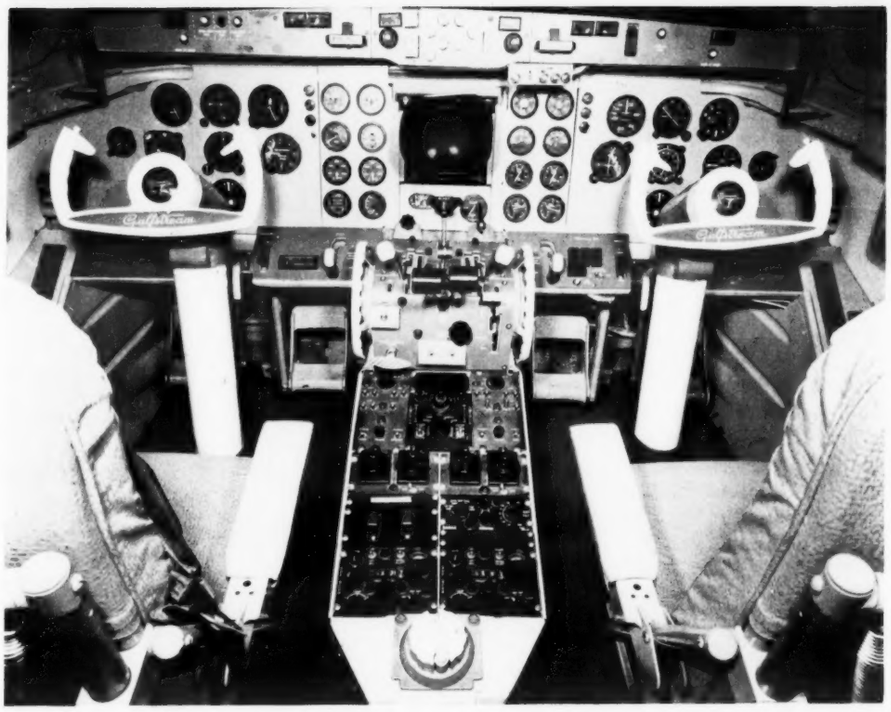
The *fuselage*, built up of three parts and of semi-monocoque construction with stringers, rings and stressed skin, has ten large elliptical windows (19 × 26 inches) and a passenger door with built-in stairs (forward left). The four windows above the wings, and a hatch in the cabin roof serve as emergency exits. Toilet and baggage room are arranged immediately in front of the pressure-tight bulkhead, and the six front and side windows in the flight deck consist of laminated, electrically de-iced NESA glass.

Like the ailerons, the tail control surfaces are entirely manually operated (or by the servo motors of the autopilot). All control surfaces can be blocked from the pilot's seat by means of mechanical gust locks, and an interlock safety system prevents both engines being run up to full power simultaneously while the gust locks are activated. The leading edges of the fin and horizontal tailplane are also pneumatically de-iced.

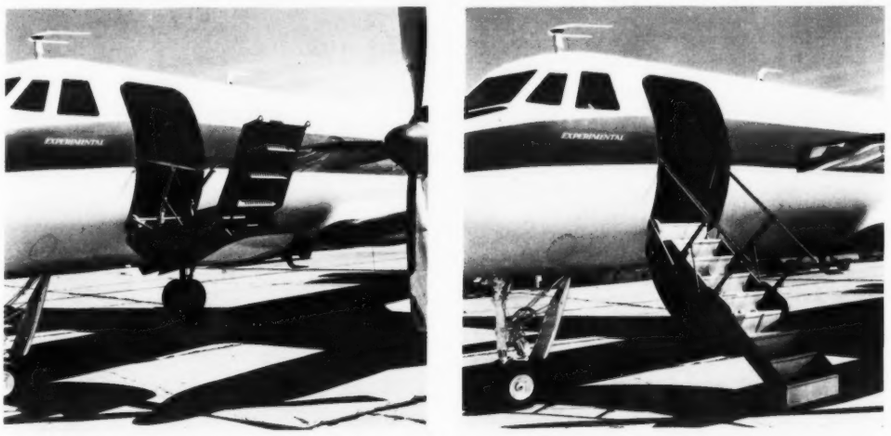
Pressurization is supplied by a Roots-type supercharger driven by the starboard engine. In addition, there is an auxiliary turbine engine in the rear fuselage (with compressor and D.C. generator) to provide air conditioning when on the ground and to start the propeller turbines. It can also be used as an alternative source of air for pressurization purposes.

Needless to say, the *Gulfstream* will normally be equipped with the latest radio and navigation equipment available today: dual VHF communication and navigation system, dual glide slope receiver, dual ADF, single marker beacon receiver, possibly an HF voice communication equipment, DME system and radar transponder... not to mention a weather radar.

Although best-known for its carrier-based fighters, Grumman Aircraft Engineering Corporation is no newcomer to the manufacture of civil aircraft. It has produced three types of civil, twin-engine amphibians *(Gray Goose, Widgeon* and *Mallard)* in large numbers since 1936 and has maintained its position in the "semi-civil" field with the quantity production of the *Tracker, Trader* and *Tracer* submarine patrol aircraft, transport and early warning aircraft. Altogether Grumman has sold more than 24,000 aircraft since 1930.



Pilot's seats and instrument panels in the *Gulfstream:* above the flight and navigation instruments is a narrow panel for warning lights and emergency controls; the controls for the radio and radar equipment are behind the central pedestal; those for the electrical system, de-icing, pressurization and fuel systems, starter, propellers etc. are above head level. The inner arm rests fold upwards to provide easier access to the seats.



The hydraulically-operated "integral" stairs in semi and fully opened position.

The Grumman *Gulfstream's* cabin normally offers accommodation for ten passengers in comfortable individual seats. Each passenger has his own large window (the same size as a *Viscount* window). A "high-density" version for up to 19 passagers is also available.

A Medium-Calibre Mobile AA Battery

A new twin-35 mm calibre AA gun of great accuracy has been produced by *The Oerlikon Machine Tool Works, Bührle & Co.* This weapon has a high rate of fire and has been designed to fill a gap in the range of guns of this type at present available. Both the weapon and the ammunition have been developed on behalf of an un-named foreign power, but study of the whole assembly, including a new type of mounting and the ammunition feed system, has been undertaken by the company on its own initiative. A special feature for a battery of this calibre is the incorporation of the Contraves *Bat* fire control system which, combined with the qualities of accuracy, high rate of fire and destructive potential, results in an ultra-modern general purpose weapon for air defence.

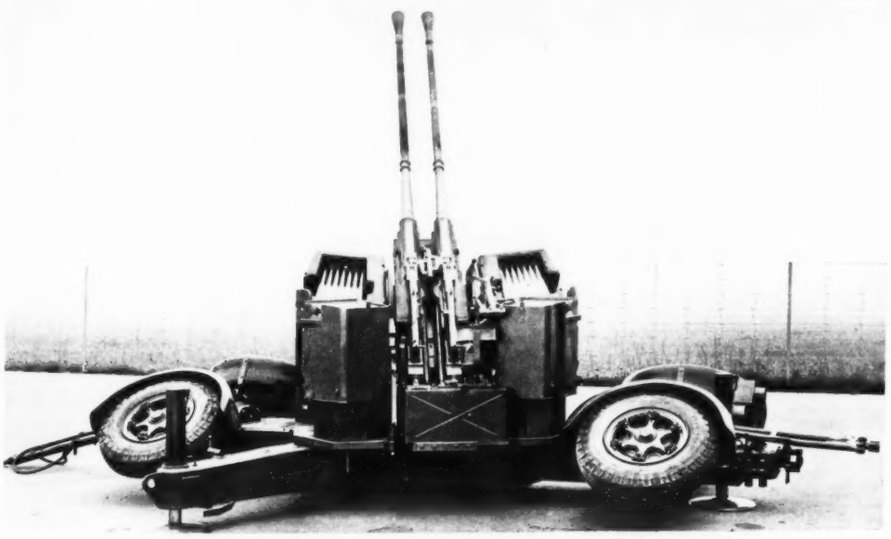
Fully automatic elevation and traverse is provided to enable rapid laying; continuous fire can be maintained for a maximum period of nine seconds due to the new type of feed system evolved for this gun. Although predominently a field weapon, it is also suitable for use in an armoured SP AA gun or as turret armament on naval vessels.

The Oerlikon-Contraves 35-mm battery has the following special features:

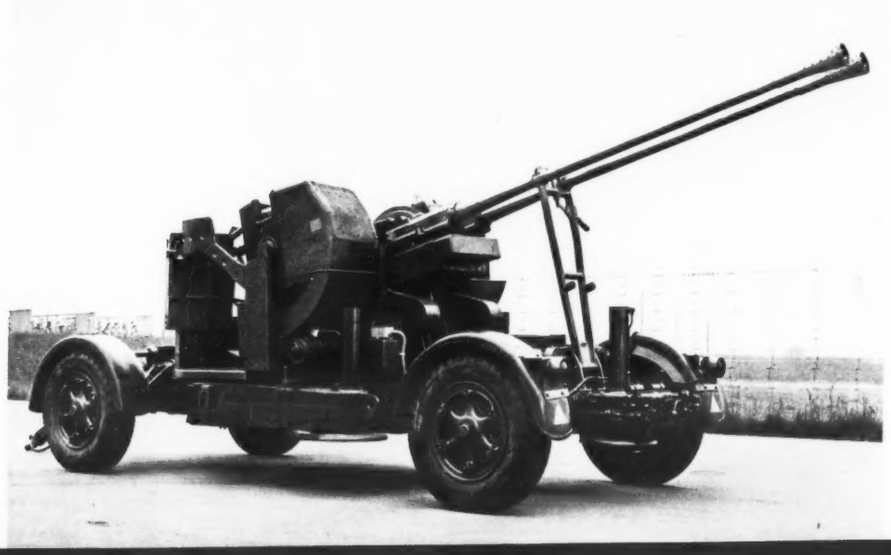
- Fully automatic electronic fire control with radar, providing unambiguous target acquisition and instantaneous transmission of gun-laying data;
- Powered drive giving high-speed gun laying;
- Outstanding accuracy due to high firing rate and muzzle velocity, low dispersion ratio, and short-flight shell of advanced aerodynamic design;
- A stable mounting;
- Optimum destructive effect of each shell (120 g Hexal);
- 238 rounds ready for firing at each gun;
- The weapon can, if necessary, be reloaded during aiming and firing.

From a tactical viewpoint, maximum mobility is achieved with a minimum number of vehicles and personnel. Each gun and the fire control system has a separate power supply which is installed with other ancillary equipment in a second trailer. Supply cables are distributed between the three power units and are wound on drums incorporated in each generating set. Since every weapon is accompanied by its own power supply, the units can be quickly brought into action because the cables are immediately ready for connection and the battery can then be controlled automatically. If required, the gun carriage can be supplied with detachable wheels so that the gun and power supply form an integral fighting unit, without the central fire control system if necessary. The weapon can also be either electrically or manually controlled by one operator, independently of the fire control system.

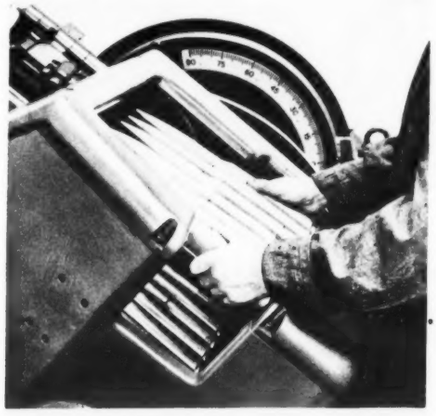
Each gun is equipped with two *Oerlikon Type 353 MK 35 mm* gas operated guns with an automatic firing mechanism, a firing rate of 550 rounds per minute (1,100 rounds per twin unit) and a muzzle velocity of 3,500 ft. per second. The piece is mounted on recoil runners and has automatic breech locking actuated by the recoil system. The latter comprises hydraulic damping with spring recuperation to ensure smooth operation and a high degree of stability when the gun is in action. Initial cocking is by hand lever



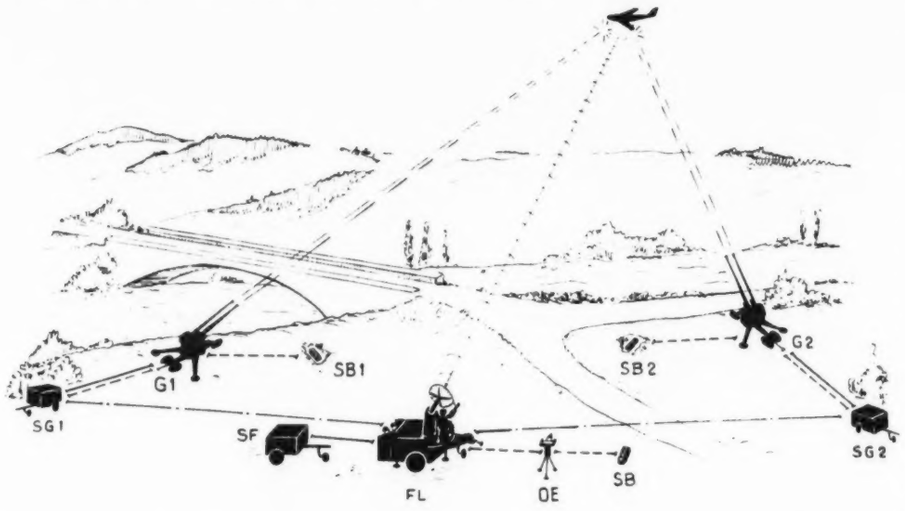
Medium calibre Oerlikon Type 1-ZLa/353 AA Machine gun (35 mm) in firing position (above) and in travelling trim. Magazine capacity: 2 × 56 rounds with 2 × 63 rounds in reserve; rate of fire 2 × 550 rounds per minute.



The seven rounds are inserted into the magazine from above, either after or during firing.



Two 35 mm AA Oerlikon 1-ZLa/353 on a firing range in the Swiss Alps.



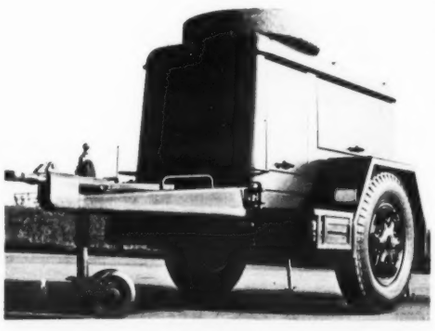
A layout sketch of a 35 mm AA battery showing two guns, a fire control post, power generating units and other equipment.

FL	*Bat* fire control	SG 1	Power supply for No. 1 gun
OE	Optical indicator	SB 1	Signal Box for No. 1 gun commander
SB	Battery Commander's Signal Box	G 2	No. 2 gun
SF	*Bat* power supply	SG 2	Power supply for No. 2 gun
G 1	No. 1 twin gun	SB 2	Signal box for No. 2 gun commander

Heavy lines represent power supply cables; heavy dashes signal cables; dots and dashes combined power supply and signal cables.

The *Bat* fire control system includes provision for sighting, radar scanning, plotting and computing.

Each complete gun unit and the fire control post includes a petrol-engined generator, cable and a built-in drum.



but equipment for electrical operation can be fitted if required. The weapon may be fired either mechanically or electromagnetically with single shot or continuous fire settings.

The gun carriage has independent suspension throughout with fourwheel hydraulic brakes operated by the driver of the towing vehicle. A mechanically-operated hand brake is also fitted to the rear wheels. All four mudguards are constructed of synthetic rubber.

An electric pump, with emergency manually operated gear, lowers the chassis hydraulically from the travelling to the firing position and swings the road wheels outwards; the chassis then rests on three jacks which can be operated optionally either by hydraulic or manual control. Automatic levelling compensation is provided to correct any displacement of the weapon during firing. Elevation and traverse are by electric motors with fully automatic operation through the fire control system, or by one-man joy-stick remote control via a direct coupling. The maximum directional speeds are 120° per second and 60° per second for traverse and elevation respectively. In the event of full power failure, the gun can be manually laid by one operator. The minimum overall height is approximately 5 ft. 2 in. in the firing position and 6 ft. 6 in. in travelling position.

Each barrel has a constant feed magazine, mounted on the gun housing. The loading clip contains seven rounds and weighs 22½ lb. full and 14 oz. empty. The clips are fed into the magazine from above, and magazine loading can continue during firing. Each barrel has an immediate supply of 56 rounds (one in the breech and 55 in the magazine) permitting a 6.1 second sustained burst of fire; this may be prolonged to 9.6 seconds by feeding the magazine while the gun is in action.

Rapid central fire control for all units is ensured by electrical transmission from the Battery Commander's Signal Box (SB), from which emanate, firstly, signals giving the state of readiness for action of each unit and, secondly, orders for firing to commence. An optical indicator (OE) enables the Battery Commander to direct the aim of the guns under his control at any target he may choose, a delay of about two seconds being required for each change of target. The Signal Boxes SB1 and SB2 are each connected to one gun and, during full automatic control, orders from the Battery Commander pass through them to the respective units. In cases of emergency, firing of either gun can be interrupted via the corresponding signal box. All key points in the battery are interconnected by telephone.

The ammunition developed by Oerlikon for use in the 35 mm automatic gun is particularly notable for its outstanding ballistic properties and high destructive power. Modern standards for safety both in handling and firing medium calibre ammunition have been fully satisfied. The explosive employed is the well-tried type known as *Hexal* which, while producing a good blast and being an efficient incendiary, is also chemically stable and suitable for storage. A delayed-action impact fuse is fitted, and the following types of projectile are at present available: HE incendiary with self-destroying fuse; HE incendiary tracer with self-destroying fuse; armour piercing HE incendiary with self-destroying fuse; armour piercing solid core tracer; practice rounds; practice rounds with tracer.

What's in the Air?

Extracts from Interavia Air Letter, *daily international news digest, in English, French and German. All rights reserved.*

Short Brothers & Harland have developed a new type of freight lift for the RAF Transport Command's Britannia *253s. The lift can be dismantled and carried inside the aircraft. Powered by an electric motor, the freight lift can raise loads of up to 12,000 lb. Dimensions of platform 14 × 12 ft.*

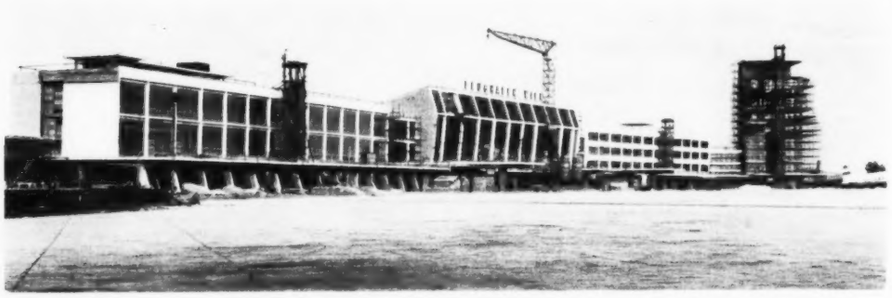
AIR TRANSPORTATION

● **United Air Lines** has ordered an additional seven Boeing 720s, bringing the total number on order to eighteen. The new order, which includes spare engines and parts, is valued at $35 million, and brings the carrier's total commitments for jet aircraft to $310 million. This includes 40 Douglas DC-8s, the first of which was delivered on June 3rd, and which will be introduced into service late this summer.

● **British Overseas Airways Corporation** is studying the question of a short/medium haul jet for some of its own and for its associates' services. The requirement seems to boil down to a multi-engined 600 m. p. h. transport with 70-75 seats. The two aircraft at present under examination, which might meet this requirement, are a slightly scaled-down version of the de Havilland DH.121 and the ducted fan Bristol 205.

● **Aeroflot** has introduced a Leningrad-Vladivostok service with the Tupolev Tu-104A. The flight time over the 5,000-mile route is between 13 and 14 hours, including intermediate stops at Sverdlovsk, Novosibirsk and Irkutsk.

● **Aeroflot** has placed a £100,000 order with Pye Ltd. for two of the company's landing systems for installation at Moscow airport. Aeroflot is making a six months' trial of Decca navigator equipment on its international European flights.



A new terminal building is now nearing completion at Schwechat airport, Vienna. In the centre is the terminal proper, with an area of about 50,000 sq. ft. and a height of nearly 60 ft. To the left is the 300 ft. long, 45-ft. high restaurant, to the right the control tower and the four-floor office wing, which is about 280 ft. long and nearly 50 ft. high.

● **Alitalia's** summer timetable includes two new services, to be operated by the Elivie helicopter company, linking Naples to Capri and Ischia. From June 15th to September 30th five flights will be made daily to each island with four-seat Agusta Bell 47J *Ranger* helicopters.

● **KLM airliners** are to have a new external colour scheme, and the names *Vliegende Hollander* and *Flying Dutchman* will disappear. Both sides of the fuselage will be painted with a red, white and blue band with the name *KLM-Royal Dutch Airlines* above. The tail will carry a white circle with the initials *KLM* in red.

● **Austrian Airlines** inaugurated a Vickers *Viscount* Vienna-Moscow service on June 2nd, departing on Fridays and returning on Saturdays.

● **Sudan Airways** has been admitted as the eighty-eighth member carrier of the International Air Transport Association (IATA).

● **The Air Research Bureau** held its General Assembly in Stockholm on May 22nd under the chairmanship of SAS President A. Rusck. The following airlines were represented: Aer Lingus, Air France, Alitalia, BEA, BOAC, DLH, Iberia, Icelandair, KLM, SAS, Sabena and Swissair. The annual report for 1958 and the budget for 1959 were adopted. Also approved by the meeting were administrative arrangements for a new system of centralized control for the production of joint timetable information for the European network. The Bureau also reported further progress on the establishment of an organization to promote a European travel market survey, and the ARB is cooperating with other European travel organizations in this work.

At the end of May 1959 the fiftieth Boeing 707 left the final assembly line at the Boeing Transport Division's plant in Renton, Washington. The following Boeing 707's have been completed to date: 17 for American Airlines, 8 for Pan American World Airways, 14 for TWA, 3 for Continental, 3 for Qantas, 1 for BOAC, 1 for Braniff and 3 for the USAF.

● **The 52nd Annual Congress of the Fédération Aéronautique Internationale** (FAI) in Moscow unanimously re-elected Miss Jacqueline Cochran of the United States as President.—The meeting accepted a proposal by Miss Cochran to investigate the possibility of setting up a fund to enable the Association's activities to be expanded. New commitments to be undertaken would include the promotion of aviation in under-developed countries. It was agreed that a commission should be established to bring the Association's statutes up to date and to study a system for homologating space records.—Dipl. Ing. Wolf Hirth of Stuttgart was awarded the Lilienthal Medal for his work over many years in the field of gliding.

INDUSTRY

● **Seven aviation research institutes of West Germany** agreed in Göttingen on May 29th to form a new society under the title Deutsche Gesellschaft für Flugwissenschaft e. V. (DGF). The objects of the society are to promote the aviation sciences, particularly in the field of applied research, and to subsidize, or itself operate, research facilities. It will take over the responsibilities accepted over the last two years by the Central Council of the Aviation Research Institutes. The committee of the new society comprises Professor Dr. Hermann Blenk (DFL) as Chairman, with Professor Dr. Hermann Schlichting (AVA) and Dipl. Ing. Otto Fuchs (DFS) as members. The Federal Republic's 1959 budget estimates contain a DM. 15.34 million subsidy for the DGF.

● **The new Sud Aviation SE-3200 Frelon helicopter,** powered by three Turboméca Turmo IIIs, made its maiden flight on June 9th.

● **The Wassmer WA.40** four-seat sports and touring aircraft made its first flight at the Brétigny Test Centre on June 8th in the hands of Test Pilot Cormerais.

● **Decca Radar Ltd.** has received an order to supply Decca weather radar for Geneva and Zurich airports. The equipment will be installed by Radio Switzerland, Berne, acting on behalf of the Swiss Federal Air Office.

● **The Raytheon Company** has received orders for two complete air route surveillance radar systems to be installed at Geneva and Zurich airports. The equipments will provide complete radar surveillance of the whole of Switzerland from altitudes of 16,400 to 78,800 feet. An Amplitron amplifier unit can raise the power from 500 kw to 4 MW and increase the 325-km range by over 70 percent.

● **Doman Helicopters Inc.,** Danbury, Connecticut, and Industrie Meccaniche Aeronautiche Meridionali Aerfer, of Naples, have signed an agreement under which the Doman LZ-5 helicopter will be manufactured under licence at the Pomigliano d'Arco factory. Aerfer also acquires sales rights for Central Europe.

● **Sikorsky Aircraft Division** of United Aircraft Corporation has received an order from the Federal

Flight trials of the Fairey Gannet *AEW. 3 early warning radar aircraft on the aircraft carrier H.M.S.* "Victorious". *The Fairey* Gannet *AEW.3, equipped with a new version of the Armstrong Siddeley* Double Mamba, *carries a crew of three men: the pilot and two radar operators.*

The Handley Page Dart Herald *has recently returned from a successful demonstration tour of India. Shown in the picture is the* Dart Herald *at Leh airfield in the Himalayas. The aircraft is to be demonstrated in various Latin American countries in July.*

The DC-8 assembly line at the Douglas Aircraft Company's Long Beach plant. Nineteen carriers have so far placed orders for a total of 140 Douglas DC-8s.

Richard W. Lee has been elected President of General Precision Laboratory Inc., Pleasantville (N.Y.).

E. G. Davidson (left) takes over as Aviation Manager of Air BP from John Sanderson (right), who has been appointed to the general management of BP's associate in Sweden.

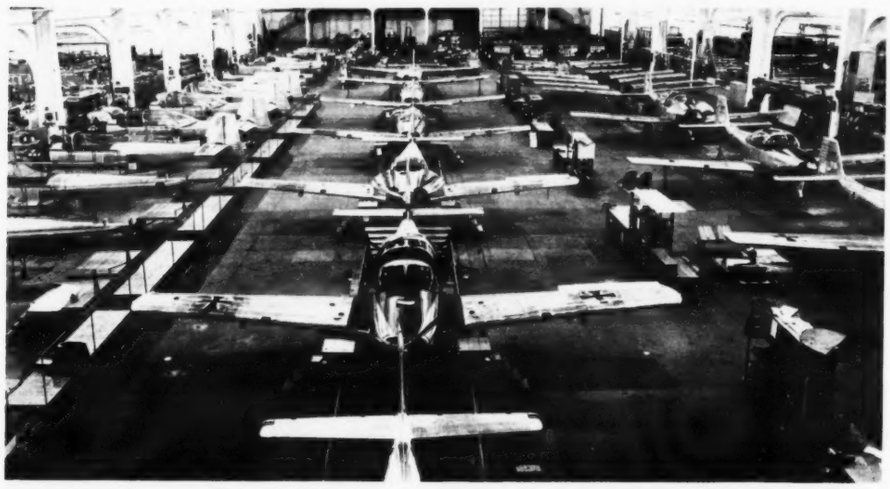
Important guests at the celebrations to mark the opening of the Bad Godesberg Aviation Club founded by Mano Ziegler, Editor-in-Chief of «Flug-Revue», and Colonel Fritzherbert Dierich. Left, Federal Minister of Defence Dr. Franz Josef Strauss, with Adolf Krogmann, President of the Aviation Club. Right, Brigadier General W. Panitzki, Chief of Staff to the Inspector General of the Bundeswehr, Brigadier General Lothar von Heinemann, Chief of Staff and Deputy Inspector of the Air Force, President Adolf Krogmann.

German Defence Ministry for twenty-five Sikorsky S-58 helicopters and spare parts to the value of about $8.7 million. From July of this year four helicopters are to be delivered per month.

● **Compañía Mexicana de Aviación** has placed a £4 million order for three de Havilland *Comets 4s* with spare parts. De Havilland has not yet confirmed the order.

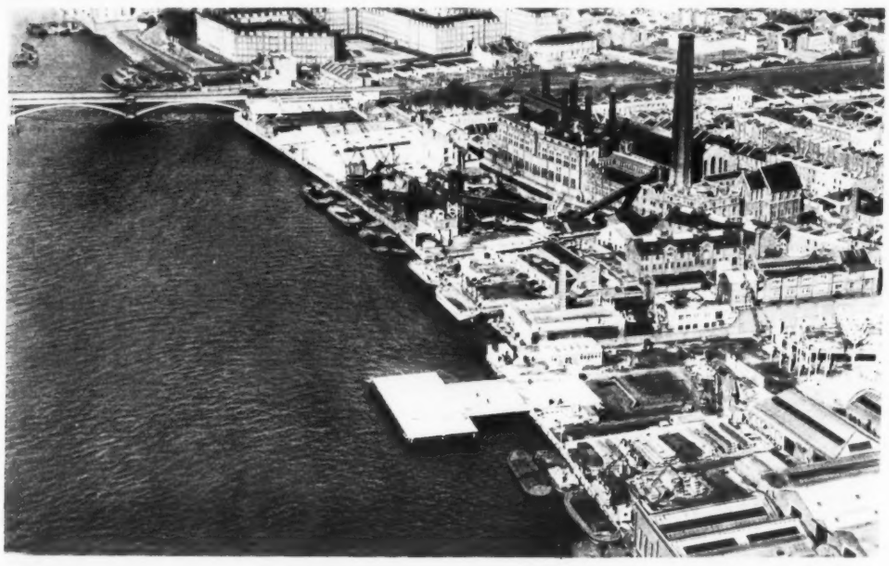
● **Orenda Engines Ltd.,** Malton, has announced the appointment of Earle K. Brownridge as President. Brownridge was formerly Executive Vice-President and General Manager, and will retain his responsibility as General Manager.

● **Jacques Grangette,** Test Pilot to Société Potez-Air Fouga, took up the first production model of the CM.175 *Zéphyr* on its maiden flight at Toulouse-Blagnac airfield on May 30th. A total of thirty CM.175s has been ordered by the French Navy. The *Zéphyr* is the naval version of the *Magister* jet trainer and was formerly known as the *Esquif*.



Construction under licence of the Italian Piaggio P.149D multipurpose aircraft at the Focke-Wulf GmbH plant, Bremen. Focke-Wulf has been awarded a German Air Force contract to build 190 FWP.149Ds.

A bird's-eye view of Westland Heliport, London. The landing area, situated between Battersea Railway Bridge and Wandsworth Bridge, can be used by all helicopter operators. Westland Aircraft Limited is financing the heliport, and International Aeradio is responsible for traffic control.



● **Three de Havilland Gnome turboshaft engines,** each of 1,000 s.h.p. will power the new Agusta 101G helicopter. The 101G is to be tested in flight later this year.

● **The Curtiss-Wright TDU-12B Skydart 1** rocket powered target drone has been successfully tested and launched at the Air Proving Ground Center, Eglin AFB. The *Skydart 1* is built around a small solid propellant rocket motor having a single chamber.

● **The North American X-15** rocket research aircraft made its first free flight on June 8th, 1959. The X-15 was released from the Boeing B-52 parent aircraft at an altitude of 38,000 feet and reached the ground after a 6-minute glide. The landing speed was approximately 230 m.p.h.

● **The Morane-Saulnier MS.880 Rallye,** a two-seat sports aircraft of all-metal construction with a 90 h.p. Continental motor, was flown for the first time by Test Pilot Jean Cliquet at Villacoublay on June 10th.

MILITARY AFFAIRS

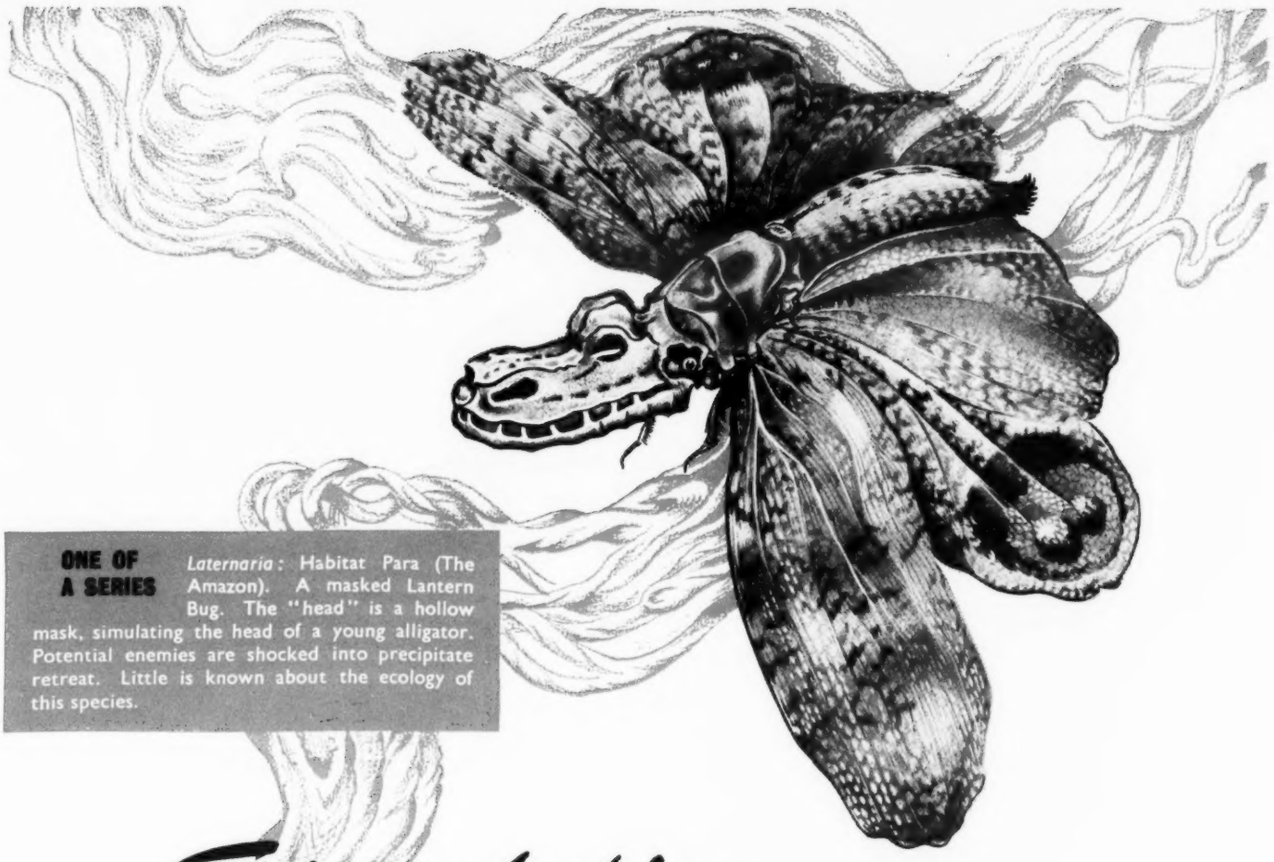
● **RAF Transport Command** received its first Bristol *Britannia 253* at Lyneham, Wiltshire. on June 9th. The *Britannia* has 117 rearward facing seats and can also be used as a freight transport. The floor will withstand a point load of 1,000 lb/sq. in. and a total load of up to 15.5 tons. The *Britannia 253* is the first Transport Command aircraft to be equipped with TACAN Doppler for navigation.

● **The British Army,** whose Air Corps is at present limited to aircraft with an all-up weight not exceeding 4,000 lb, is expected to extend its flying activities along the lines of the U.S. Army. It is reportedly interested in liaison aircraft, VTOL transports, crane-helicopters and attack aircraft.

● **Lieutenant-General Josef Kammhuber,** Inspector of the German Air Force, officially inaugurated the first Air Force fighter wing at Ahlhorn/Oldenburg on June 6th. The unit, which is to be known as the 71st Fighter Wing, comprises two squadrons, each of 18 Canadair *Sabre VIs*. Commanding officer is Major Erich Hartmann.

● **The Italian Air Force** will, according to reports from Rome, be equipped with the Republic F-105, manufactured by an Italian firm under licence. NATO is reportedly backing this proposal in order to ensure continued productivity for the Italian aircraft industry following rundown of the North American F-86K production.

Italian visitors at the Douglas plant in Santa Monica. Left to right: General Silvio Napoli, Italian Air Force Chief of Staff, Donald W. Douglas Jr., President of the Douglas Aircraft Company, Major-General Mario Bucchi, Head of the Coordination Section of the Italian Air Force General Staff. During his stay in the USA General Napoli was awarded the Legion of Merit.



ONE OF A SERIES *Laternaria:* Habitat Para (The Amazon). A masked Lantern Bug. The "head" is a hollow mask, simulating the head of a young alligator. Potential enemies are shocked into precipitate retreat. Little is known about the ecology of this species.

Simulation to Perfection

Shock-induced reactions have no place in aviation.

Airlines and Air Forces invest in Air Trainers Link simulators to provide the practice and training necessary for safe, reliable operation.

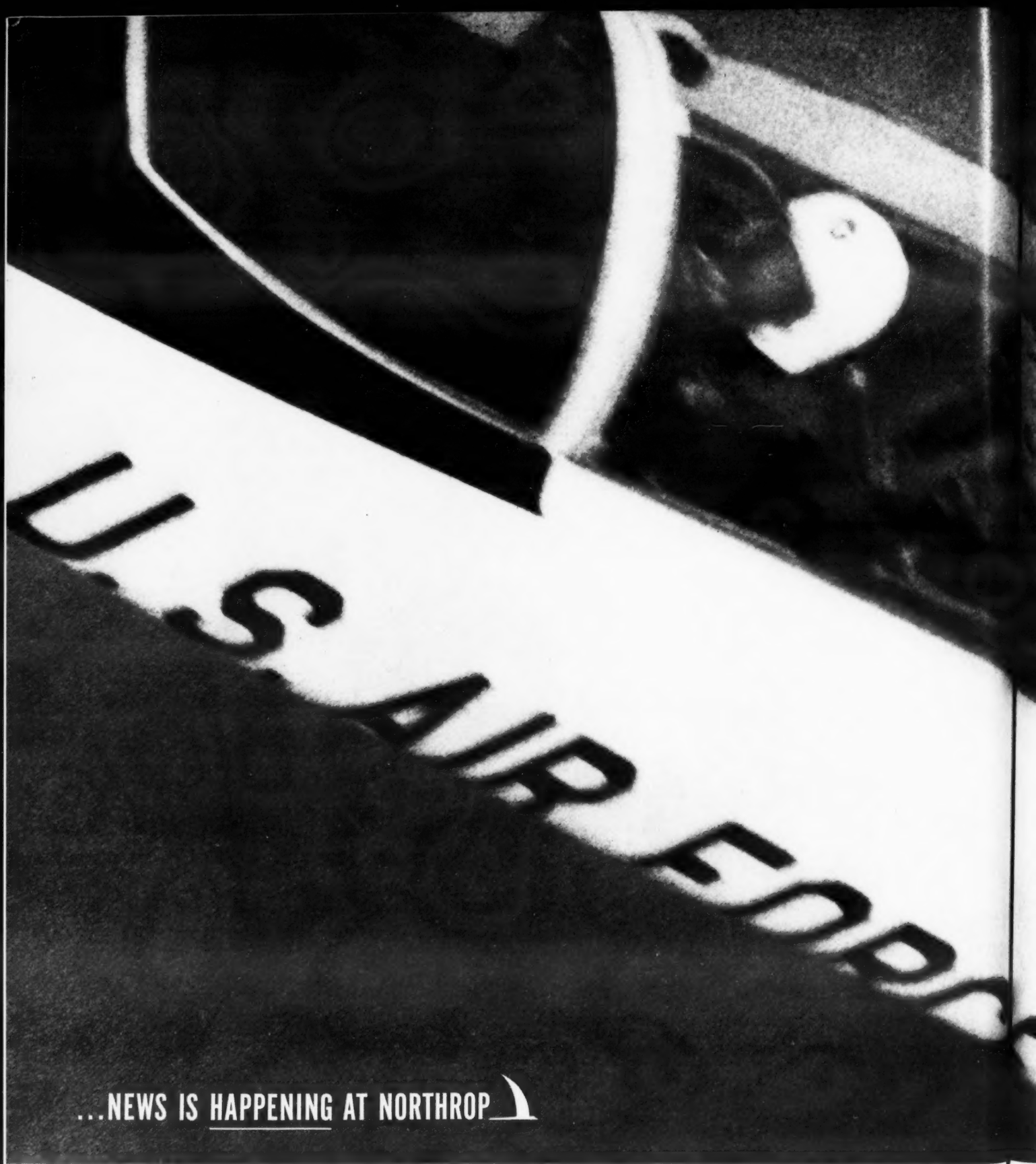
Executives appreciate the economies made possible by the use of high-fidelity simulators for the essential instrument rating and proficiency checks.

AIR TRAINERS LINK LIMITED

AYLESBURY BUCKINGHAMSHIRE ENGLAND

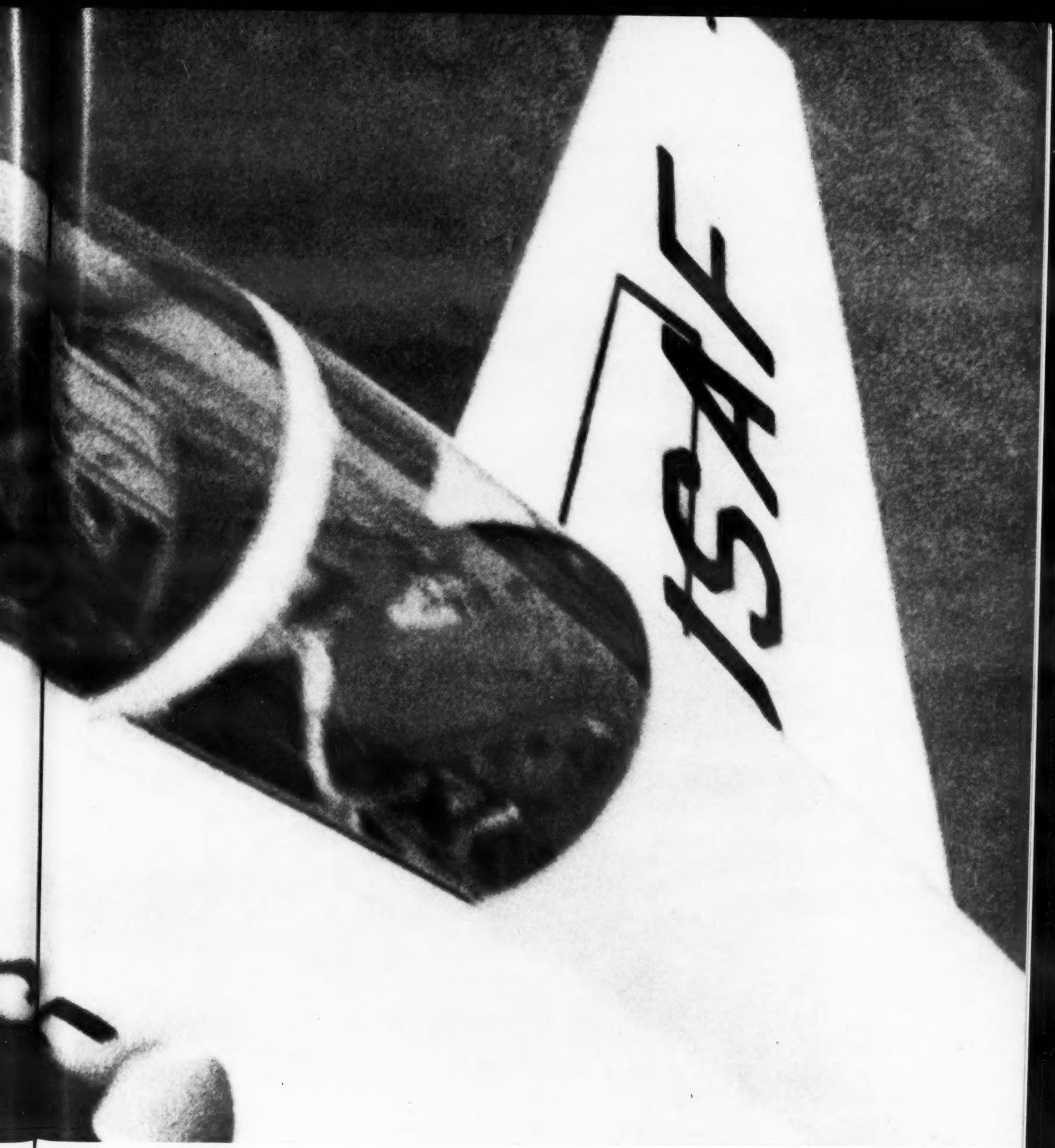
Telephone: AYLESBURY 4611/7

Telegrams: "Trainair" AYLESBURY



AIRBORNE! FIRST MEMBER OF N-156 AIRCRAFT FAMILY!

SUCCESSFUL FLIGHT OF USAF T-38 PROVES HIGH PERFORMANCE OF NORTHROP LOW-COST AIRCRAFT!



Successful flight tests at Edwards Air Force Base, California, indicate that the USAF-Northrop T-38 Talon more than qualifies for its unique mission. Now in production under USAF contract, it fills a vital need for a high-performance, low-cost aircraft in which the new generation of space-age airmen can safely master the art of supersonic flight.

BEING DEVELOPED IN PARALLEL IS NORTHROP'S N-156F – the only fighter under USAF contract created especially to fit the specific tactical and economic requirements of other free-world nations. The N-156F – the Freedom Fighter – is a supersonic weapon system that offers total combat effectiveness superior to any other American front-line fighter.

The N-156F matches effectiveness with economy. It costs far less to buy, to fly, and to maintain. And of equal importance, the Freedom Fighter is designed for production outside the United States and will make a substantial contribution to the economies of the free-world countries it will defend.

NORTHROP INTERNATIONAL
Beverly Hills, California, U.S.A.
A Division of Northrop Corporation

GUIDED MISSILES
GUN FIRE CONTROL SYSTEMS
ANALOG COMPUTERS
SERVO MECHANISMS

Already being delivered to several
N. A. T. O. countries

Gun Fire Control / System
for 40 mm guns

CONTRAVES ITALIANA S.p.A. ROMA

RAPID Mobility

with the STOL Caribou

The Caribou cabin will accommodate 32 troops.

•

The aircraft can take off with this impressive load in a distance of 530 feet. *(161.5 m.)*

•

It can move these men from place to place at a speed of 156 knots. *(289 kph.)*

•

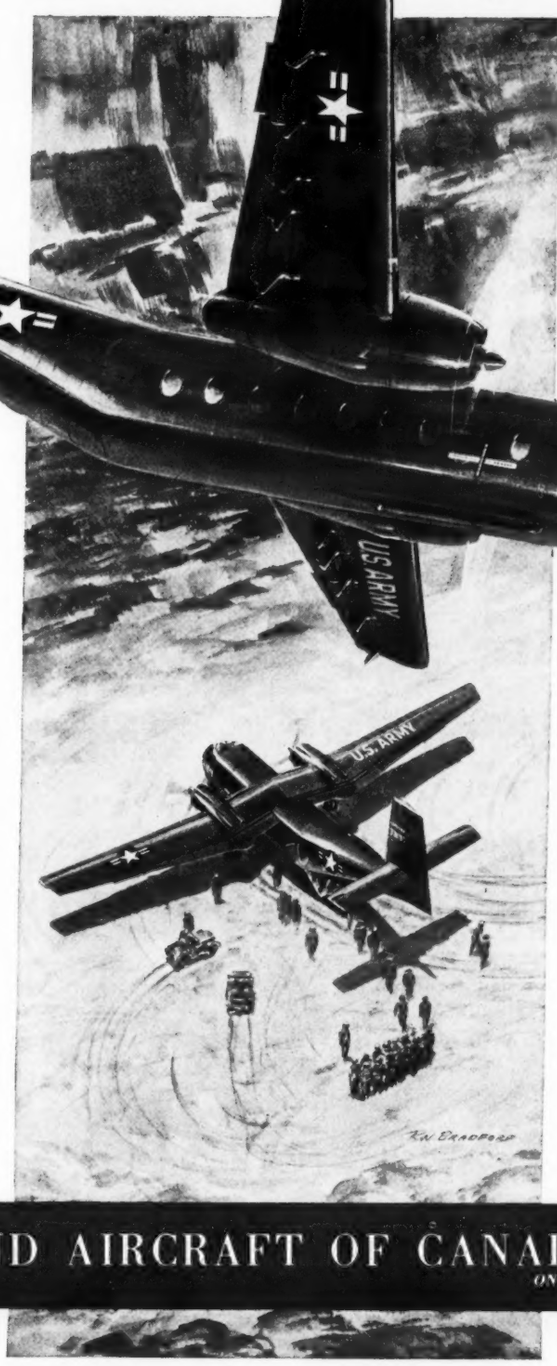
Large rear loading door permits loading (or deplaning) 32 troops in 40 seconds.

•

A Caribou has loaded and unloaded 3 tons of cargo in 5 minutes total turn-around time. *(2722 kg.)*

•

In the new concept of lightning war, the Caribou's ability to move big loads in and out of small improvised landing strips quickly means greater concentration of our land forces through the use of **RAPID MOBILITY.**



DE HAVILLAND AIRCRAFT OF CANADA
DOWNSVIEW *ONTARIO*

NEWEST MEMBER IN A FAMILY OF GREATS

The Canadair-Convair '540', by the application of turbine power, becomes the ultimate development of the widely used and approved Convair 240-340-440 series. The '540' is now on order and in full scale production.

6 MAJOR REASONS

why the '540' is the new challenger on short-to-medium routes!

1 DEFINITELY LOWER OPERATING COSTS

The standard 48-seat Canadair-Convair '540' offers **a direct operating cost of 1.4¢ per seat mile which comes down to 1.1¢ in the 58-seat configuration.** Over distances as short as 80 miles, its economy of operation matches even that of piston-engined aircraft.

2 GROWTH CAPACITY TO MEET GROWING ROUTE DENSITIES

The Canadair-Convair '540' has the built-in capability of growing with the increased traffic densities that are forecast for the years ahead. It can do this because its **seating capacity can be increased by 20%** from 48 to 58 **without weight or operating penalty.** All fuel for terminal-to-terminal operation could still be carried.

3 MATCHED-TO-TASK JET-PROP ENGINES

The Napier 3500 e.h.p. engines that power the Canadair-Convair '540' are **the only jet-props specifically designed for the particularly strenuous up-and-down life of short stage operations.** The sectionalized design of these powerful new engines make them singularly easy to service and maintain.

4 REDUCED EN-ROUTE GROUND TIME LOSSES

The Canadair-Convair '540' **eliminates numerous possible time delays at en-route stops:** passenger handling is expedited . . . time consuming engine warm-ups are unnecessary . . . as many as 6 route stops can be made without refuelling.

5 FASTER FLYING, QUICKER CLIMBING

Today's passengers want to **make time.** The Canadair-Convair '540' is **the fastest aircraft in its class,** flying at speeds up to 340 m.p.h. It's off the ground in a flash and takes only 6.4 minutes to climb to an operating level of 10,000 feet.

6 EXTRA CARGO SPACE FOR EXTRA PROFITS

The Canadair-Convair '540' has 402 cubic feet of easily accessible cargo space: enough for **two tons of additional payload** that can be carried with no operating penalty.

MOST IMPORTANT TO YOU: the Canadair-Convair '540' is a product of the combined experience and facilities of two of the world's great aircraft producers—Canadair Limited of Canada and Convair—both members of the General Dynamics family of companies.

THE CANADAIR-CONVAIR '540' WILL SOON TOUR WESTERN EUROPE

For full information about the new aircraft or the tour, please contact our European Representative, J. H. Davis, Princes House, 190 Piccadilly, London, W. 1, England.

CANADAIR CONVAIR 540

JET-PROP AIRLINER

CANADAIR, MONTREAL, CANADA

THE CANADIAN SUBSIDIARY OF GENERAL DYNAMICS CORPORATION CA59-540-22UKT

missile
guidance
THOMSON CFTH HOUSTON
COMPAGNIE FRANÇAISE THOMSON-HOUSTON - GROUPE ÉLECTRONIQUE - 173, BD. HAUSSMANN, PARIS-8e

MULTI-MISSION FIGHTER

The F-104 Starfighter

Never before has a single airplane done so many things so well as the Lockheed F-104 Starfighter. Its missions include:

Identification
Interception
Bombing
Reconnaissance
Attrition
Air Superiority

After a two-year evaluation period during which West German Defense Ministry experts investigated and flight-tested airplanes made by twelve competing manufacturers, the plane selected for purchase and manufacture under licence in West Germany was Lockheed's famous "missile with a man in it", the F-104. Designs for future production were also evaluated but it was decided that nothing exists, even on paper, likely to displace the F-104 as the world's best multi-mission fighter.

Holder of the world speed, altitude, and seven time-to-climb records, the F-104 has been still further developed to meet the specific needs of West Germany and other allies requiring a multi-purpose fighter instead of several separate aircraft for specialized needs. To its already amazing performance is being added all-weather capability for fighter, bomber and interceptor missions and also an advanced reconnaissance capability.

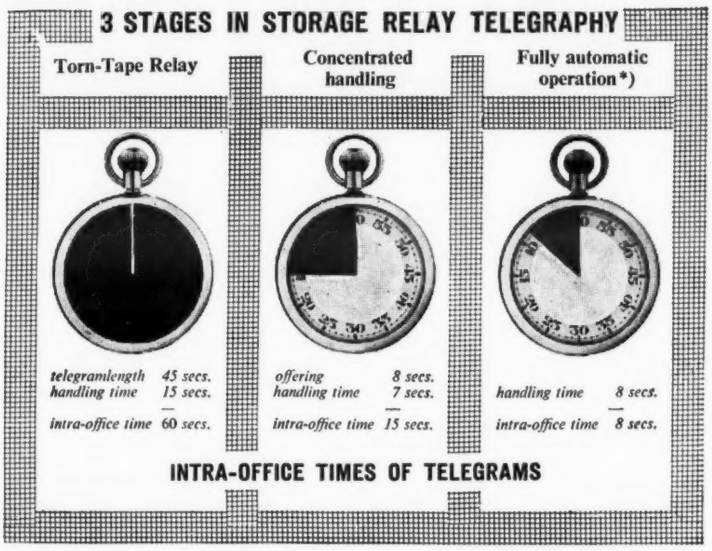
The licensing of German manufacturers to produce this advanced version will make it available to West European nations at relatively low cost.

For NATO countries the versatility of the F-104 means that one airplane can accomplish all fighter functions—and with low proven maintenance and operating costs.

LOCKHEED

JET TRANSPORTS · JET FIGHTERS · JET TRAINERS · COMMERCIAL & MILITARY PROP-JET TRANSPORTS · ROCKETRY BALLISTIC MISSILE RESEARCH & DEVELOPMENT · WEAPONS SYSTEMS MANAGEMENT ANTI-SUBMARINE PATROL AIRCRAFT NUCLEAR-POWERED FLIGHT · ADVANCED ELECTRONICS · AIRBORNE EARLY-WARNING AIRCRAFT · AIRPORT MANAGEMENT NUCLEAR REACTOR DESIGN & DEVELOPMENT · GROUND SUPPORT EQUIPMENT WORLD-WIDE AIRCRAFT MAINTENANCE

23
1950: 2000 m
23
1957: 2600 m
23
1960: 3900 m
GENEVA
is preparing
for the jet aircraft age
GENEVA AIRPORT



*** Last stage** towards automation:
Fully automatic operation!*)

Fully automatic operation can be applied to circuits where a fixed discipline for the composition of the telegrams can be relied on. This results in minimized intra-office times.

PHILIPS

ES

Electromagnetic Storage

Electromagnetic stores are the outstanding feature of Philips' new semi-automatic and fully automatic ES telegraph exchanges for large public and private telecommunication networks. They temporarily store telegrams and routing information so that channels can be operated with maximum efficiency. Flexibility of design makes it possible to use the three stages side by side in the same telegraph centre. The equipment is easily expanded for gradual introduction of fully automatic working.

N.V. Philips' Gloeilampenfabrieken/Telecommunication Division, Hilversum, The Netherlands

PHILIPS

Designed for the future, available now

an advertisement from Philips KEY CAPITALS series.

The Summit of Civil Aviation

Twelfth Session of the ICAO Assembly, San Diego, June 1959

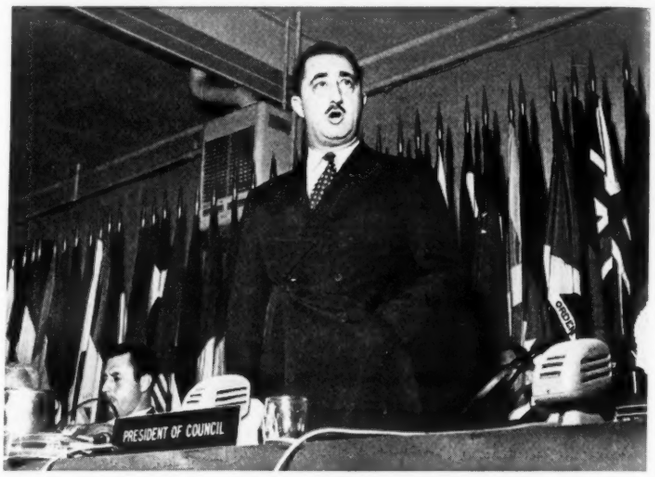
During recent years, full ICAO General Assemblies (now with 74 member nations) have been held at intervals of several years and have been convened in principal cities in the ICAO Regions, unlike the intermediate or "minor" sessions which have been held in Montreal. In addition to general administrative questions, the General Assembly discusses all aspects of the most important problems facing civil aviation.

The full 12th Session of the General Assembly met in San Diego, California, on June 16th, 1959. The outgoing ICAO Council presented a report which clearly showed the increasing emphasis which is being given to the economic problems of civil aviation in the ICAO programme, now ranking in importance with the technical problems.

It is already widely known that the rate of traffic expansion decreased in 1958; deviating sharply from the trend of the last six years, which had shown average growths in total traffic of about 15 percent per annum, the 1958 rate of expansion dropped to about one third of that figure, i.e. about 4.3 percent. The rate of growth for airlines in different countries varied considerably, with the smallest increase recorded in the United States: USA + 1 percent, UK + 6 percent, France + 7, Netherlands + 3. The largest increases were recorded by: Belgium, up 33 percent; Canada, up 18 percent; and Brazil, up 18 percent.

Despite the greatly increased load factors recorded on the early jet services, the average load factor for the 1958 year was the lowest recorded since World War II: 1949—55 percent; 1951—62.5 percent; 1956—59.3 percent; 1957—57.4 percent; 1958—54.8 percent.

The financial results reflect this decrease; 1958 balance sheets for the world's scheduled carriers are not yet available, but ICAO anticipates that the deficit will be higher than in 1957. Total operating revenue is estimated at $4,200 million, with operating expenses probably rising to $4,360 million. Average unit revenues per tonne-kilometre were approximately 41 cents (59.9 cents per ton-mile) in 1958, compared with 40.5 cents (59.1 cents per ton-mile) in 1957.



Walter Binaghi, outgoing President of the ICAO Council, presents his report to the 12th session of the Assembly.

In 1955, the ICAO estimated that the annual cost of route air navigation facilities for international air transport throughout the world would be $60.5 million. Estimates for 1959 are about $100 million and ICAO considers that approximately 80 percent of this sum is contributed by Governments of ICAO member States.

The following series of articles by heads of the principal ICAO bureaux will illustrate the wide range of activities undertaken by this international organization.

The Economic Field

by E. M. Weld,
Assistant Secretary General and Director of the Air Transport Bureau

In general terms it may be said that the aims of ICAO in the economic field are, in the words of the Chicago Convention, to foster the orderly development of international air transport in such a way as to ensure the provision of regular, efficient and economical services; the prevention of economic waste caused by unreasonable competition; and the avoidance of discrimination. ICAO's function is to serve as machinery by means of which the governments of ICAO's contracting States may work together towards these objectives. In line with this function, ICAO has assisted in the establishment in Europe of regional apparatus, in the shape of the European Civil Aviation Conference (ECAC), to facilitate international collaboration on a regional basis. Within ICAO and ECAC, governments have achieved a large measure of coordination in their economic and administrative policies in the field of air transport.

The first specific economic objective of ICAO's contracting States, both chronologically and in order of importance, has been a worldwide multilateral agreement on the exchange of

The Assistant Secretary General of ICAO, Edward Motley Weld, *is a lawyer. He was born in 1906 at New York City and from 1938 until 1941 he was Principal Attorney for the Civil Aeronautics Authority, now known as the Civil Aeronautics Board. During the second world war, he became a Major in the USAF and was responsible for all USAF contracts with the U.S. air transportation industry. Mr. Weld has held his present appointment with the ICAO since 1945.*
Editors.

commercial rights. As is well known this agreement has never been achieved and commercial rights are still exchanged on a bilateral basis. However, there has been some progress. General agreement has been achieved as to the rights accorded to non-scheduled operations by Article 5 of the Chicago Convention and on the difficult problem of defining these operations, and in Europe, through ECAC, a multilateral agreement has been attained giving them substantial freedom to operate freely within that region. Moreover, the whole subject of the granting of commercial rights has been thoroughly studied on a world-wide basis. The policies of States regarding passenger stopover rights have been analyzed and considerable progress has been made toward the development of standard administrative and technical clauses for use in bilateral agreements.

On some other important subjects States have, through ICAO, achieved general agreement expressed in the form of Council statements of policy. Such statements have been adopted on charges for the use of airports and route air navigation facilities; on air mail transportation charges; on international taxation problems and on the reduction of burdensome insurance requirements for international operation. These statements were drawn up on the basis of thorough studies of the subjects in question. The air mail and charges studies were published for general distribution, as have been other studies on such subjects as the pooling of air services and the economic implications of the introduction into service of jet aircraft.

Facilitation — The Battle against Red Tape

If consular, customs, immigration, public-health and other formalities require one hour at each end of a trans-oceanic flight of seven hours, for example, the total elapsed time of the trip is increased by almost 30 per cent. To meet these needs, the International Civil Aviation Organization has developed, inter alia, international standards and recommended practices (Annex 9) on facilitation of international air transport and a statement of ICAO's aims and objectives in this field (Doc 7891-C/906). Some observers estimate that, in the past ten years, delays for passengers and cargo by air have on the average been reduced by more than one-third at airports of arrival and departure; and that the transit time at intermediate airports on international air routes has been reduced by as much as a half in many cases.

Joint Financing

Although each member State of ICAO undertakes to provide in its own territory the facilities needed for air services, the cost of certain facilities sometimes exceeds the resources of the States concerned, or certain services must be provided in regions of undetermined sovereignty. One of the marked achievements of ICAO since its inception has been to arrange for the joint financing of such facilities in the North Atlantic Region through contributions in kind or in cash from the States which operate air services over that ocean.

At the present time three joint financing agreements in which 18 States participate are administered by ICAO. They deal with the provision of facilities costing more than $12,000,000 a year. Twenty-one vessels are used to man nine Ocean Stations that provide many meteorological, communications and search and rescue services; three Loran Stations, as well as a considerable number of meteorological, communications and air traffic control facilities are provided in Greenland and Iceland. There will also be included in 1961 or 1962 a submarine cable ensuring direct voice and teletype communications between air traffic control centres in the North Atlantic region.

Air Navigation

by T. S. Banes,
Assistant Secretary General and Director of the Air Navigation Bureau

T. S. Banes was born at Washington in 1911 and qualified as an Electrical Engineer in 1933. During the second world war, he became Chief of Communications with the USAF Air Transport Command. After a short period in industry after the war, he joined the forerunner of ICAO, PICAO, as Chief of the Communications Section in the Air Navigation Bureau. Mr. Banes organized many of the air navigation meetings of the ICAO between 1948 and 1956.

Editors.

A chaotic situation faced international civil aviation at the end of the 1939-1945 war. Military demands had telescoped decades of technical development into years, and had proven the practicability of mass air transportation of passengers and cargo anywhere in the world. On the other hand, the procedures, regulations and equipment for international civil aviation in much of the world had been swept away or made obsolete, and an entire new structure had to be created. Obvious reasons dictated the need for standardization and uniformity in many elements of this new structure.

"*... the International Civil Aviation Organization shall adopt and amend... international standards and recommended practices and procedures dealing with...*" (Article 37 of the Convention). This Article goes on to list a number of broad fields, mostly technical, and concludes with "such other matters concerned with the safety, regularity and efficiency of air navigation as may from time to time appear appropriate." The purpose was to establish worldwide uniformity in policies, equipments and practices where such uniformity was essential or advisable.

Through scores of worldwide meetings over the past 14 years, the recommendations of which are examined, coordinated and approved by its Air Navigation Commission and Council, ICAO has produced international standards, recommended practices and procedures covering all important aspects of aeronautical telecommunications, radio and visual navigation aids, rules of the air, air traffic services, aeronautical meteorology, aerodromes, search and rescue, airworthiness of aircraft, aircraft operating practices, personnel licensing and training, aeronautical information services, aeronautical maps and charts, use of dimensional units, aircraft registration markings, and accident investigation practices. This material has been published in 14 Annexes to the Convention, which comprise the basic regulations, supplemented by 5 documents on Procedure which describe in detail the way in which certain air navigation functions are to be executed. Additionally, 12 manuals have been published containing guidance material, standardized codes and abbreviations, etc., and intended for field use. All the foregoing documents are amended as necessary to keep them abreast of changing requirements and advances in the state of the art.

"*Each contracting State undertakes, so far as it may find practicable, to... adopt and put into operation... the operational practices and rules*" (Article 28 of the Convention). The response of contracting States to this obligation has in general been gratifying. Although many governments have not complied with all provisions of the Annexes and Procedures, the deviations have almost invariably been in matters of detail and not of principle. ICAO takes justifiable pride that, broadly, international civil aviation throughout the 74 contracting States and over the high seas operates and receives its supporting technical services in accordance with the operational practices and rules established by ICAO.

"*Each contracting State undertakes, so far as it may find practicable, to provide in its territory airports, radio services, meteorological services and other air navigation facilities... in accordance with the standards and practices*" (Article 28 of the Convention). Between the establishment of international standards by ICAO and the provision of facilities and services by the individual States lies the need to determine specifically what installations are necessary, and where and when to permit safe, efficient and regular international operation. For this purpose ICAO convenes meetings, in each of the 8 air navigation regions into which it has divided the world, of the countries geographically within the region, the other countries whose aircraft fly in the region, and representatives of interested international organizations. These meetings prepare plans to meet the needs of present and foreseeable international civil operations, specifying in full detail the aerodromes and their characteristics, the air traffic services

scheme and associated installations, air-to-ground and point-to-point communications circuits, navigational aids, meteorological services and installations, search and rescue organization and equipment, and regional procedures and practices supplementary to the worldwide ones.

The problems confronting States in the implementation of this huge programme are, broadly, financial, technical and training.

Through visits to States, informal meetings and correspondence, the ICAO secretariat in Headquarters and particularly in the Bangkok, Cairo, Lima, Mexico and Paris Regional Offices, has given a great deal of assistance to governments singly and collectively in overcoming technical difficulties in implementation. The training activities of the Air Navigation Bureau have produced a Training Manual in 15 parts, giving guidance to instructors in as many different aviation specialties; numerous training films, posters and recordings have been prepared and distributed, and instructions for building an air traffic control/communications trainer and a radar trainer have been developed and published.

The overall problem of implementation, particularly its financial aspects, is far from solved, however, and is probably the most important and difficult matter now facing ICAO. A concentrated effort has been made over several years to identify the true causes of deficiencies in implementation, and to find remedies for them. The findings will be submitted to the ICAO Assembly in San Diego.

Legal Work of ICAO

by P. K. Roy,
Director of the Legal Bureau

After obtaining a B.A. degree at Nagpur University, India, and being called to the Bar in London, P. K. Roy was appointed a Civil Judge and Magistrate in the Central Provinces, India, in 1934. He became the Indian delegate to the ICAO Assembly and Member of the Legal Committee in 1946, and was Deputy Secretary to the Government of India in charge of civil aviation from 1949 until 1953 when he joined the ICAO as Director of the Legal Bureau.

Editors.

Legal work in ICAO falls within the functions of various organs. Thus, the Assembly deals with constitutional and legal policy questions; and the Council is the authority for interpreting the Chicago Convention. Also the Council, with the Air Navigation Commission, participates in a unique system of international legislation on civil aviation through the adoption of Annexes to the Convention. I shall, however, deal here only with the legal work of two organs, namely the Secretariat and the Legal Committee.

Legal Bureau

Until 1947, the secretariat of the ICAO was composed of the Air Navigation Bureau, the Administrative Bureau and the Air Transport Bureau; the latter also included a Legal Studies Section with a small staff and, in 1948, this was expanded into a Legal Bureau to operate in direct relationship with the Secretary General.

Amongst the most important functions of the Legal Bureau is the giving of legal advice to the Council and other organs of ICAO. Such bodies often seek the legal advice of an international secretariat not only on purely legal issues but also on other questions which have legal aspects, whether of constitutional or policy import or relating to international air navigation or air transport or administrative and financial matters.

Other continuing activities of the Legal Bureau are to collect national laws and regulations on civil aviation and to study legal problems related to international civil aviation. In accordance with the Chicago Convention, all aeronautical agreements and arrangements concluded by every Member State with any other State or airline are registered with the Organization which is also the depositary of several Conventions and international agreements. The Legal Bureau has charge of these matters. The Bureau also conducts research and renders services in relation to the work of the Legal Committee of the Organization, about which more anon.

Legal Committee

The Convention on International Civil Aviation established specialist organs related to air navigation and air transport, but in none of its 96 articles is there any direct or indirect reference to the establishment of a specialist legal organ. However, Article 49 (k) of the Convention confers on the Assembly the power to " deal with any matter within the sphere of action of the Organization not specifically assigned to the Council ". That competence was sufficient for the Assembly, at its First Session in 1947, to constitute a permanent committee to deal with legal matters, called the Legal Committee.

According to its constitution, adopted in 1947 and revised in 1953, the duties and functions of the Legal Committee are to advise the Council on matters relating to the interpretation and amendment of the Convention on International Civil Aviation; to study and make recommendations on such other matters relating to public international air law as may be referred to it by the Council or the Assembly; to study problems relating to private air law affecting international civil aviation; and to prepare drafts of international air law conventions. The Committee is composed of legal experts designated as representatives of and by contracting States, with each such State having one vote.

International recognition of rights in aircraft

The earliest task of the Legal Committee was to formulate rules to ensure international recognition of the ownership, mortgage and other rights in aircraft crossing international frontiers, so that investors would feel secure in providing financial assistance for the purchase of new aircraft. It prepared a convention on that subject which was opened for signature at Geneva in 1948 and to which, by the end of April 1959, eleven States had become parties.

Damage caused by foreign aircraft to third parties on the surface

The Legal Committee, after extensive studies by the Secretariat and the Committee, prepared a draft convention on this subject. A final text was adopted at a diplomatic conference convened by ICAO in 1952. The convention, to which eight States had become parties by the end of April 1959, makes the operator of the aircraft liable, irrespective of any question of fault on his part, in respect of damage caused to persons or property on the ground or water surface of any State by a foreign aircraft in flight or by any person or thing falling therefrom. Such liability, however, is limited according to a scale based on the weight of the aircraft.

Revision of the Warsaw Convention

Under this Convention, to which fifty-two States are parties, the air carrier is liable in respect of death or injury to passenger or damage to goods during international carriage by air, but is exonerated if he establishes that he took all necessary steps to avoid the damage. However, he will not be liable, except in a case of wilful misconduct, above specified limits which, in respect of a passenger, is 125,000 gold francs, equivalent to $ 8,291 (USA). With the passage of time and in the light of experience in air transport operations and in view of changes in economic conditions and currency values, revision of the Convention became necessary. Therefore,

the Legal Committee prepared a Protocol to that Convention, which was adopted at a diplomatic conference convened by ICAO at The Hague in September 1955. The Protocol will come into force if ratified by thirty States, ten of which have already done so. It provides, among other improvements, that the limit of liability shall be double the amount mentioned above and simplifies the documents of carriage, reducing the particulars of the passenger ticket, baggage check and air waybill.

Hire, charter and interchange of aircraft

For solution of certain legal problems associated with the recently growing practice of hire, charter and interchange of aircraft amongst air carriers, the Legal Committee, at its session held in Tokyo in 1957, formulated a draft convention which, at present, has the somewhat technical title: Draft Convention for the Unification of Certain Rules Relating to International Carriage by Air Performed by a Person Other than the Contracting Carrier. It is applicable where the air carrier with whom a passenger or consignor of goods has entered into a contract of carriage governed by the Warsaw Convention arranges that such carriage or part of it will be performed by another carrier. The draft provides that the latter carrier will, in respect of the carriage performed by him, be liable to the passenger, consignor or consignee in the same manner as is provided by the Warsaw Convention and the Hague Protocol with, however, an exception in the case of the carriage of cargo.

Aerial collisions

A draft convention was prepared on this subject by the Legal Committee in 1954. It provides that in the event of a collision between two or more aircraft, the operator at fault shall be liable within specified limits and that in the case of fault of two or more operators the liability of each for damage shall be in proportion to the degree of his fault. In view of increasing numbers of aerial collisions IATA has recently requested early action towards the adoption of a convention on the subject.

Legal status of aircraft

In September 1958 one of the sub-committees of the Legal Committee formulated a draft convention to apply in cases of offences or acts dangerous to safety committed on board aircraft engaged in international air navigation. The draft also includes rules which would enable commanders of aircraft to maintain order on board. The draft is to be considered by the Legal Committee at its forthcoming session at Munich (West Germany) on 18 August, 1959.

Other subjects

The work programme of the Legal Committee, and consequently of the Bureau, includes several other subjects for study, such as the legal status of the aircraft commander; uniform rules of procedure for cases arising under conventions on air law; promotion of a uniform interpretation of air law conventions; problems of nationality and registration of aircraft operated by international agencies. One project now on the horizon is a study on the relationship of airspace and air law with outer space and development of law relating to outer space. This work will be done in coordination with the United Nations, or with any other international body interested in this field.

The ICAO Technical Assistance Programme

by E. R. Marlin,
Director of the Technical Assistance Bureau

The Director of the ICAO Technical Assistance Bureau, E. R. Marlin (USA) was born fifty years ago in New York. He joined the Civil Service in 1935 and held a variety of diplomatic appointments in the USA and abroad until he became Consultant to the Canadian Preparatory Committee on PICAO in 1945. He has been Director of Technical Assistance with the ICAO since 1952.

Editors.

ICAO shares in the United Nations Expanded Programme of Technical Assistance because a large number of countries are convinced of the importance of aviation to their national economy.

One may, perhaps, describe the programme briefly as economic development through technical self-sufficiency. Under the programme, ICAO cannot supply aircraft, machinery, aerodromes, equipment for air navigation services or anything concrete. The burden of development must be assumed by the State or by national enterprise; and technical assistance should not lead to unhealthy development. What Technical Assistance does is to help the State create the conditions under which, whether by private or government agencies, a healthy development of civil aviation may take place.

The work under the ICAO programme may be divided into two broad categories—advice and training. Experts are sent to countries to give advice. Training is given partly by sending instructors to a country, partly by granting fellowships to nationals of the country to enable them to undertake abroad studies which cannot be pursued in their own country.

The greatest part of the whole effort goes into training. Experience has fortified ICAO in its original belief that the greatest impediment to development of aviation services is lack of trained personnel. Training of personnel is by no means the most expensive item in a development plan, but it is something without which no kind of technical equipment can be used and no technique of operation established. A well-trained man will make better use of obsolete or obsolescent equipment than an untrained man will make of the most modern and the most expensive.

ICAO has therefore established training centres varying in size with the requirements of the country, staffed them with instructors and supplied them with the technical equipment needed for training. This training has been up till now largely basic training for aircraft mechanics, radio mechanics, radio operators, air traffic controllers, meteorological observers, general power plant mechanics, and so on. It is a long-term plan and it demands a continuity of effort. The aim has been to start training programmes from which well grounded tradesmen will emerge and provide a good cadre for future technical development. A certain amount of advanced training has also been given, particularly through fellowships.

Advice has covered a wide field and a fairly large number of activities. It has covered, for example, the drafting of national aviation laws, on-the-job training of technical and administrative staff, the solution of technical problems to do with siting and installation of equipment for air navigation services, aerodrome design, and so on.

It is probable that while directly engaged in a task of this nature, it is difficult to attain the point of view necessary to see the whole picture of aviation development in perspective. However, whatever may be the place of this programme in the general development of world aviation, one can say that by it there have been certain helpful achievements.

Unfortunately, the demand for this technical assistance still vastly exceeds the supply. The total of the funds contributed in each of the last few years to the United Nations Programme has remained almost stationary, and aviation in each assisted country has to compete for a share of these funds with agricultural, medical and other interests in whose fields there are many weighty problems awaiting a solution. An interesting question at the present time, particularly for those who feel that the general level of technical services in even the most advanced countries is barely adequate, is to what extent an increase in the volume of technical assistance in aviation can provide a solution, and from what source funds for such an increase should and could be drawn.

An Enduring Institution of Peace

by Jacques Berrier,
Director of the Bureau of Administration and Services

Jacques Francis Berrier *is aged 50 and is a French subject. His comprehensive education was obtained at, amongst other places, Colwyn Bay, Wales, and the University of Paris where he qualified in law. From 1948 onwards until his appointment as Director of ICAO's Bureau of Administration and Services in 1955, he was Chief Administrator with the Department of Personnel, Finance and Liaison, NATO.*

Editors.

" *... to build enduring institutions of peace* "
Franklin D. Roosevelt

A single Bureau of the ICAO Secretariat combines a number of services that may be classified into two groups according to the rather different nature of their functions.

On the one hand, there is administration: finance and accounts—organization and personnel—premises, equipment and supplies. On the other hand, the Bureau is also responsible for general conference arrangements, interpretation at meetings, the preparation of minutes, and the translation, printing and distribution of all the documentation published by ICAO.

By its very concept, an institution requires continuity and permanence. After being in existence for more than thirteen years, despite a few variations, the ICAO Secretariat has maintained its stability. To anyone looking at an organizational chart, whether it be dated 1947 or 1959, no major change is apparent. Obviously, like any other active organism, the Secretariat has undergone a process of evolution and adjustment. As early as 1947, the then Legal Studies Section, which was within the Air Transport Bureau, was set up separately and became the Legal Bureau. Then, from 1950 on, a further offshoot grew up which, in 1956, became the Technical Assistance Bureau. Again, in 1956 a new Regional Office, that of Mexico, was added to the other four. A few adjustments were made in 1951, then in 1956 a further reorganization affected the grouping of activities in the Air Navigation and Air Transport Bureaux, and in the Bureau of Administration and Services. The framework, however, stands unchanged. It remains that which was born, in 1946, of the Chicago Convention.

ICAO is also characterized by its cautious budgetary policies.

From 1950 to 1959,
—the number of Contracting States rose from fifty-five to seventy-four, an increase of over a third;
—the cost-of-living index for Montreal rose by 22 per cent;
—the general wage index for Canada rose by more than 50 per cent;
—the general output of publications rose from thirty to forty-five millions;
but, over this same period, the net budget rose from $2,812,000 in 1950 to $3,757,000 in 1959, and will be $3,779,000 in 1960.

Not only is ICAO international in its scope. It is also international in its character owing to the diversity of nationalities within its staff, its language policy and the geographical distribution of its offices, technical assistance missions and meetings. In 1959 the staff comprises no less than thirty-five different nationalities, as compared with twenty-seven in 1956. The advance is worthy of note.

From its inception the Organization adopted three official languages, French, English and Spanish, which are also designated as working languages. This trilingual policy admittedly places upon the ICAO administrative services an appreciable burden, which can be estimated at approximately 15 per cent of the budget as a whole if all its various implications are taken into account.

In fourteen years, PICAO and ICAO have organized 247 conferences and meetings held in forty cities spread over the five continents. During 1959 six meetings will be held in Montreal and nine abroad. These figures include neither the thirty-six sessions of the Council and its Committees, nor the thirty-one sessions of the Air Navigation Commission, which were held at headquarters.

As early as 1947, ICAO generalized simultaneous interpretation at meetings. Over the last six years its portable interpretation equipment has been installed and dismantled in Buenos Aires, Melbourne, Brighton, Teneriffe, Manila, Cuidad Trujillo, Caracas, São Paulo and elsewhere.

The Organization's printing workshop was the first in Canada to make large-scale use of the dry photo-engraving process known as xerography, which was introduced as early as 1952. The appearance of the documents published and the efficiency of the printing plant have thus been greatly improved. Time and again delegates have expressed amazement at the often repeated *tour de force* which consists in publishing within a few hours bulky reports that come off the press simultaneously in the three versions a few hours only after the close of the discussions, an achievement made possible thanks to sound methods and organization and modern equipment.

These few illustrations bear sufficient evidence that the administration of ICAO is translating into facts the wish expressed by President Roosevelt in 1944 in his message to the Chicago Conference when he set the task of the assembled delegates: " ... to build enduring institutions of peace ".

A Visit to the Federal Aviation Agency

With a present staff of some 32,000, the Federal Aviation Agency *is the world's biggest aviation authority. It is responsible for air traffic control for all civil and military flying in the United States, for the inspection of aircraft and ground equipment, and for many other matters concerned with aviation.*

In November 1958 Interavia's *Editor-in-Chief had the privilege of meeting* Lieutenant General E. R. " Pete " Quesada, *whom President Eisenhower had just appointed Administrator of FAA, and of receiving from him the authorization for himself or one of his staff to study and report on this important organization. This opportunity came in early June this year, when Technical Editor* E. K. Barnes *was able to join an official Swiss delegation from the Federal Air Office and the air traffic control section of Radio Switzerland, who travelled to the United States to pay their respects to Mr. Quesada and visit the FAA. His account of the tasks and activities of FAA is reproduced below.*

Editors.

Mr. E. R. Quesada, Administrator of the Federal Aviation Agency. Entering the Army in 1924 he retired with the rank of Lieutenant General USAF in 1951. Prior to his appointment to the FAA he served as Special Assistant to the President for aviation matters, Chairman of the Airways Modernization Board and the President's Air Coordinating Committee.

The formation of the Federal Aviation Agency marks yet another step in both the history and the development of American aviation. The writer recently had the opportunity of visiting the headquarters of the new Agency and was given considerable insight into its development and current progress. To fully appreciate the reasons for its formation and the requirements it fulfils, it is perhaps necessary to retrace some of this past aviation history to obtain a clearer picture of the background from which the agency was developed.

The speed of development and expansion of the aviation and air transport industries over the past 30 years has greatly exceeded the most optimistic forecasts. This is particularly marked in the United States of America where the air transport of passengers and mail has long been accepted as a necessary and permanent part of the American transportation picture. The recognition by the Federal Government of the need to provide a centralized control for the regulation and promotion of civil aviation dates back to 1926 when the first Air Commerce Act was passed. This Act established an Aeronautics Branch of the Department of Commerce, whose function was to regulate the newly developing business of air transport. The Department was authorized to license pilots, develop air navigation

facilities, promote flying safety, map airways and to furnish flight information.

By 1938 the ever-increasing popularity of air travel, together with the increasing numbers of aircraft of new types and higher speeds, began to complicate the movement of air traffic in the airways. An exhaustive study of commercial aviation was made by a Presidential Commission which paved the way for the writing of the Civil Aeronautics Act of 1938. This Act created the Civil Aeronautics Administration and the Civil Aeronautics Board and allocated specific responsibilities to the two branches. The Civil Aeronautics Administration was made responsible for air safety, air traffic control, operation of airways, aviation communications and the improvement of airports. At the same time the Civil Aeronautics Board was charged with writing Civil Air Regulations, investigating accidents and regulating economic aspects of air routes and civil aviation. In 1940 certain amendments were made to the Act and under the resultant reorganization the Civil Aeronautics Board remained independent while the Civil Aeronautics Administration was placed within the Department of Commerce.

At the end of World War II, it was in this framework that American civil aviation recommenced its activities. The enormous advances made by aviation during and following the war rapidly became manifest. Larger and faster aircraft in steadily increasing numbers crowded into the airways and it became apparent that the air traffic control capabilities of the CAA were not designed to handle the situation. As early as 1948 the Air Coordinating Committee which had been established by the President two years previously in 1946, observed that " the existing techniques of air traffic control and tools available to CAA are marginal even by the pre-World War II standards ". During the 1950's yet another factor arose which compounded the existing difficulties. This was the advent of jet-powered aircraft with their extremely high speeds, and requiring new techniques in air traffic control to enable them to be fitted into the overall airways traffic plan.

In order to resolve the growing problems of this crowded airspace, the first step was the creation in 1957 of the Airways Modernization Board, with the express purpose of speeding the necessary improvements.

In the terms of the Act which created the Board it was also specified that Congress would establish an independent Federal Aviation Agency, and in 1958 legislation was passed which brought this into being. To direct this organization the President appointed Mr. E. R. Quesada to be the first Administrator of the new Agency on November 5th, 1958.

Mr. Quesada had previously served as Special Assistant to the President for aviation matters and had been chairman of the Airways Modernization Board. To assist him in the task of directing the new Agency, Mr. James T. Pyle was appointed Deputy Administrator. Mr. Pyle had previously been Administrator of the CAA, a body which was absorbed in its entirety in the structure of the new FAA.

This powerful and comprehensive organization is an independent agency reporting directly to the President, and the Administrator has been given the broad powers necessary to promote the interests of American aviation, both civil and military at home and abroad. The formation of the FAA was commenced by the transfer of the Airways Modernization Board to its control as the Bureau of Research and Development, followed by the Civil Aeronautics Administration and the safety rule-making section of the Civil Aeronautics Board complete with personnel, funds and functions. Once established, on January 1st, 1959, the FAA at once commenced to operate on a five-point plan described in the following principles.

1. To regulate air commerce so as to promote its development, safety, and requirements in national defense.
2. To control the navigable airspace and to regulate civil and military flight operations in the interests of safety and efficiency.
3. To develop and operate a common system of air traffic control and navigation for both civilian and military aircraft.
4. To develop a plan for the Agency's function in the event of war.
5. To prescribe minimum standards for design, materials and workmanship in aircraft construction and construction of other elements of aviation.

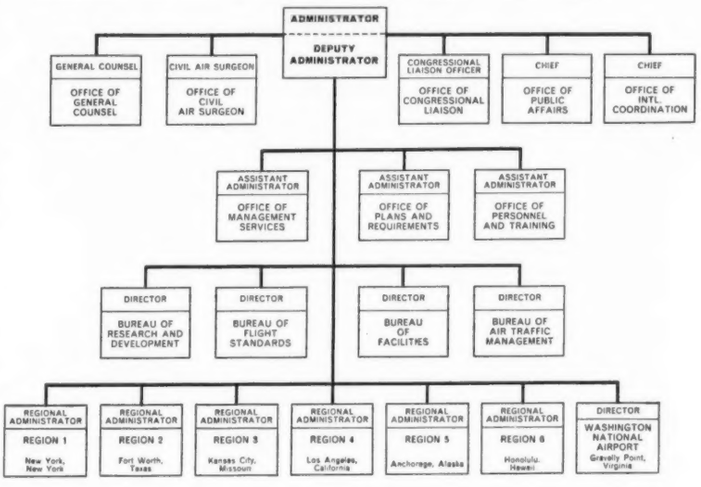
The breadth of policy embodied in this five-point plan gives an indication of the magnitude of the problems with which the Administrator and his staff are faced. It should be emphasized that the FAA concept is one of integration of services and facilities for both civil and military aviation so that it can safely and fairly apportion the use of the available airspace to both users. There is also the necessity to both expand and modernize the Federal airways system and to control the ever-growing volume of traffic. This has become even more urgent with the introduction of high performance aircraft into the traffic patterns, requiring more airspace than ever before.

In a recent interview Mr. Quesada explained to me how the FAA is attacking these problems. The first task is to maintain and operate facilities already in existence and by reducing the size of restricted areas to restore large tracts of airspace to public use. This was being achieved by complete derestriction of certain areas, and in certain other cases by allowing the use of restricted areas to civil aircraft when military operations were not being conducted. This was now possible owing to the closer integration between military and civil control in the FAA system. To achieve this integration new methods have been evolved. Military personnel are transferred for employment with the FAA rather than being attached for liaison. During the period of employment with the FAA the man is regarded as being an FAA employee even to the extent of being paid by the Agency and not by his parent Service. By absorbing this personnel into its own structure rather than establishing liaison officers from the various Services and Commands, the FAA is assured of a closer cooperation without the tendency for inter-service priorities to arise. Similarly the controllers on military airfields will eventually be replaced by civilian FAA employees to ensure a greater continuity. In consequence military aircraft will use the airways under civilian control and with exactly the same degree of priority as civilian aircraft.

The second and largest part of the programme is that of modernization of the airways; increased installation of radar and other electronic equipment, training larger numbers of traffic controllers, improving communications and developing new control procedures. This intensive research and development programme is being undertaken with the target date of January lst, 1963 as the deciding factor. Mr. Quesada explained that this date represents the completion of the first stage in the modernization programme and any new developments are judged on their availability for employment by that date. Any systems or ideas which may arise but which cannot be developed for employment in that time will be relegated to a long term research programme. By making this rule the FAA is assured of concentration on the present problem without being sidetracked on possibilities rather than certainties.

Members of the Swiss delegation with the Administrator FAA during their visit to Washington. Left to Right : H. Wildi, Swiss Federal Air Office ; A. Fischer, Chief of Air Traffic Services, Zurich airport ; A. Münch, Deputy Director, Swiss Federal Air Office ; Mr. E. R. Quesada ; M. Treyer, Chief of Air Traffic Services, Geneva airport ; H. Brechbuhler, Radio-Switzerland, Berne.

Organization chart showing the structure of the Federal Aviation Agency.



Console of the experimental Automatic Ground/Air/Ground Communication System (AGACS). This system is under development for the FAA by the Radio Corporation of America. It will provide 2-way communication with up to 500 aircraft in 2 minutes and is an example of the automatic systems now being developed to modernize the handling of air traffic.

The third and last part of the overall programme, and representing only a small proportion of the effort at the moment, is that of investigation of future developments and planning for the more distant future. This is being done with the next generation of high-speed aircraft in mind and has little bearing on the immediate modernization of the airways and facilities.

To undertake the responsibilities with which it is charged, the FAA anticipates employing nearly 40,000 personnel when fully staffed. More than 90% of this figure will be stationed in hundreds of FAA facilities throughout the United States and the world. Mr. Quesada went on to describe the main features of the organization and the main departmental responsibilities which have been established throughout the Agency. Four major Bureaux constitute the operational strength of the FAA and their functions and interdependence can best be understood by describing their activities separately.

Bureau of Research and Development. This was the first part of the FAA to be brought into existence and consolidated the research programmes of the Airways Modernization Board and the Civil Aeronautics Administration. The Bureau operates the National Aviation Facilities Experimental Center in Atlantic City, N.J. to evaluate ground navigation and traffic control equipment and procedures.

This Center is the FAA's proving ground and has been established in one of the busiest traffic areas of the United States to provide a " real life " environment of air traffic management studies. At the same time traffic free areas over the Atlantic Ocean provide a safe area for testing experimental devices. The development of semi-automatic air traffic control systems is one of the major tasks of this Bureau.

Bureau of Facilities. Is responsible for the installation and maintenance of all aids to navigation, both visual and electronic, in the air traffic control and navigation systems. It is also the engineering, construction and procurement authority of the FAA. The navigation aids for which it is responsible include VOR, VORTAC, ILS, high intensity approach lights, long range and surveillance radar installations, radio ranges, air route traffic control centres and airport control towers, data processing systems and communications. The Bureau installs these facilities and establishes the technicians to ensure their continued performance and reliability. One specialized responsibility is that of planning and developing the International Airport for commercial jets, now being constructed near Washington at Chantilly, Virginia.

Bureau of Flight Standards. The key word of this Bureau's activities is " safety ". Its activities include establishment of the standards for use by manufacturers in the design and construction of aircraft, flight testing and airworthiness certification of all civil aircraft and maintenance standards and practices for civil aircraft. It tests and certificates the competence of all flight personnel, mechanics and dispatchers and sets the standards for mechanics training schools. Safety inspectors of the Bureau continually check the actual operation of commercial aircraft and their crews on routine flights. It also has the responsibility for flight checking the navigation aids, landing aids, radars and communication systems throughout the Federal Airways Systems.

Bureau of Air Traffic Management. The function of this bureau is the control of air traffic, writing and enforcing air traffic rules and regulations and determining the division and use of the airspace available. It operates the 35 Air Route Traffic Control centres and over 200 airport control towers. It is also responsible for the network of communications which interlink the control stations throughout the airways system.

To coordinate and supervise the work of the FAA throughout the United States and overseas possessions, regions have been established under the control of regional administrators. These regional offices are situated in New York, N.Y.; Fort Worth, Texas; Kansas City, Mo.; Los Angeles, Calif.; Anchorage, Alaska; and Honolulu, TH. Over 90% of the personnel of the FAA are employed in the facilities operating in these regions.

Apart from the work of the bureaux and regional offices a number of departments exist for the planning and administration of FAA policy and for coordination with other authorities. One of the most important of these is the Office of International Coordination. Mr. Quesada is very keenly aware of the necessity of maintaining as close relationships as possible with other governments and air traffic authorities. In his view the mandate of the FAA is world wide and any aviation developments in the USA are bound to affect aviation throughout the world. Similarly the USA cannot afford to ignore aviation developments abroad as only through the interdependence of this technical effort can the maximum mutual benefits be obtained.

The extent to which the FAA is working to obtain this exchange of technical and operational information can be judged from the work of the International Coordination Office. Apart from supporting the aims of the International Civil Aviation Organization, ICAO, the FAA is strongly supporting the civil aviation activities of certain NATO groups and provides a full-time officer for this purpose. Another FAA officer sits on the Air Navigation Commission of ICAO and is alternate to the US representative on the ICAO Council.

In order to strengthen the liaison and cooperation with civil aviation administrations of other countries a number of overseas offices have been established. There is an aircraft engineering office in Paris which assists foreign manufacturers in obtaining U.S. airworthiness certificates for their aircraft. Eight field offices in as many countries perform the necessary safety surveillance of U.S. flag operations in overseas areas and consult with and advise foreign flag operators flying to the U.S. in the promotion of air safety. There are also two flight inspection groups with flight check aircraft for the operational evaluation of various air navigation aids in cooperation and under agreement with other governments.

The establishment of the National Aviation Facilities Experimental Center (NAFEC) at Atlantic City, N.J., is another illustration of the Agency's global thinking in terms of aviation development and safety. This modern airport is being equipped for experimental purposes with all types of new systems for evaluation by a large staff of scientists and engineers. It is the hope of the Administrator that engineers from other countries will visit this proving ground and that they will work alongside the FAA staff for as long as they are able in the development of equipment and systems.

The recent visit of a Swiss delegation to the FAA headquarters in Washington, D.C. was yet another example of this international cooperation. The delegation consisted of representatives from the Swiss Federal Air Office and from the Air Traffic Services of Geneva and Zurich airports, which are operated by Radio-Switzerland. In the course of a visit lasting a week they were shown the structure and functions of the FAA and were given considerable information on the developments which were in hand for the modernization of the Federal Airways system. The value of such collaboration is particularly apparent in the case of a small country such as Switzerland, whose airports are used by a large number of foreign flag carriers, and where the geographic nature of the country necessitates an extremely accurate air traffic control system. From this visit to the FAA the Swiss delegation were able to obtain operational information drawn from a highly complex and crowded air transport system. At the same time this exchange of information is not entirely one sided. The experience gained in Switzerland of air transport operations in a mountainous country of small area is of value and is welcomed by the FAA. The problems encountered in the siting and performance of radar, VORs and other navigation equipment and the methods employed to overcome these difficulties are of importance throughout the world and not only from a national standpoint.

*

In an age when no two points on the world's surface are more than 40 hours travelling time apart, it is encouraging to see such strenuous efforts being made to expedite air transport internationally, and to bring its advantages within the reach of the greatest number of people. As the two most powerful " Air Traffic Controllers "—if they will forgive the term, in the free world today, Mr. Quesada and Mr. Pyle are to be congratulated on the vigour and enthusiasm with which they are directing the efforts of the FAA to achieve this result.

Where NATO Scientists Work Together

by Colonel Kent K. Parrot, Voorburg

In one of the smaller NATO countries—a wet, fertile land of neat green fields, dikes and windmills—the scientists of twelve NATO nations are gathered together to help solve one of the largest problems faced by NATO, the problem of air defense.

In the wake of the Russian *Sputniks*, much has been said about the military urgency of pooling the scientific resources of the Western world in order to recapture our lead in rate of technical progress vis-a-vis the Soviets.

Like many good ideas that bubble to the top of the national consciousness, it frequently happens that off in some corner of the world the idea has already been put to work. So it is in the present case.

At a place called the "*SHAPE Air Defense Technical Center*" (SADTC), the idea has been working for four years.

There, on an unlikely stretch of sand dunes into which the Dutch pump water from the Rhine to provide underground reserves of fresh water for The Hague, a group of buildings houses an international scientific organisation working for the Supreme Headquarters Allied Powers Europe (SHAPE) in the field of air defense.

It is the first undertaking of its kind within Europe. It may be yet another of the seeds from which a truly integrated and common European defense will grow.

In a period when the struggle to survive is forcing the free nations together, SADTC, in its special field, takes its place with Euratom, the European Coal and Steel Community, the European Common Market, and other joint undertakings forced to look beyond national boundaries for effective answers to the challenge of today.

The SHAPE Air Defense Technical Center opened its doors in February of 1955 with a nucleus of five people. Today it has a total staff of 250. Seventy of these are scientists gathered from twelve of the NATO nations.

During its comparatively brief life, SADTC has already proven the oft repeated point that cooperation and exchange of information breed a chain reaction that sweeps forward over technical obstacles with greater and greater speed.

Unfortunately the outstanding scientific competence of the West—one of the greatest resources of the Free World—has been held in check for more than a decade. And why ? Because we fear that, were the stream of exchange to be allowed full flow, part of it would spill over beyond friendly national borders. This fear is well founded. Leaks are inevitable where freedom of speech and press is fundamental to the way of life.

But haven't we thrown out the baby with the bath ? We have clamped down the lid in the name of security, with the result that often we hide from our friends things that are already known to our enemies. We tend to sacrifice the dynamic concept of maintaining a greater rate of technical progress for the static concept of maintaining an assumed position of technical superiority.

The following incident illustrates SADTC's international problem-solving technique: For years the Netherlands Post, Telephone and Telegraph Service had been working to improve communication with the East Indies and with Dutch possessions in the Caribbean Area, roughly eight thousand miles southeastward and five thousand miles southwestward from Holland. Finally a device was invented that did the job.

A Dutch scientist at SADTC familiar with the Netherlands Post Office work suggested in a theoretical study that the same principles might usefully be applied to an entirely different type of communication on which the Center was working.

A test was arranged, with Holland supplying the equipment, the Third U.S. Air Force supplying a radio circuit as guinea pig, SADTC running the tests, and the British Admiralty providing assistance for parts of the work.

A forward pass from Holland to SADTC to the U.S. to the U.K.—with the result that the mechanism for transmitting air defense warning information surely and instantaneously may be greatly improved. Just one of the small projects at SADTC, and yet it could mean the difference between being alerted or surprised; the difference between victory or defeat in the supersonic nuclear era.

The concept of a European Air Defense Technical Center was first suggested by the U.S. Air Force, long concerned with the lack of any effective NATO air defense. The essence of the idea was that a combined effort by European scientists on the problem of their air defense would result in solutions more in keeping with the special geographic and economic problems of Europe than could solutions exported from the United States under the Mutual Defense Aid Program.

Further, it was hoped that the creation of an establishment where the whole question of European air defense could be studied—something after the model of the MIT Lincoln Laboratories in the United States—would in itself help to bring about integrated thinking, and eventually, an integrated solution to a problem insoluble by any other approach.

But the idea might have come to naught if it had not arrived at a time when another event made it possible to do something about it.

This other event was the establishment of the *Mutual Weapons Development Program* under the Mutual Defense Aid Operation.

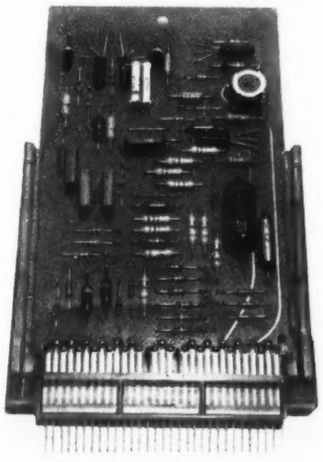
For some time the U.S. had been exporting large quantities of military hardware to friendly countries. Seldom could this equipment ever be tailored to the economy of the receiving country. Nations consequently often faced difficult financial straits unless continued U.S. assistance was forthcoming to cope with operation, maintenance, and replacement of the equipment furnished.

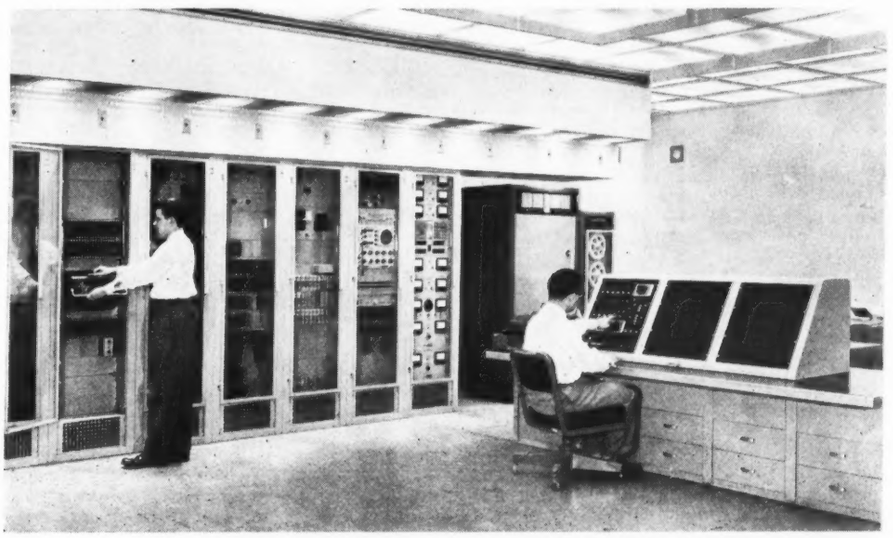
In itself, receipt of military hardware from the United States tended, in some cases, to slow down foreign research and development programs. The budget authorities would argue with their military chiefs "Why put money into expensive research and development when the U.S. may come along eventually and give us the things you are trying to develop ?"

Hence, though military aid shored up defenses on a short-term basis, there were long-term aspects of the operation which led to larger and larger demands upon the U.S., and to a gradual withering of self-sufficiency in some of the countries being helped.

And so the Mutual Weapons Development Program was born. Its object: to help countries help themselves.

Electronic computers provide the answer to atomic warfare with supersonic weapons. The computing elements of such installations (left) enable details of aircraft or missile positions to be evaluated in fractions of a second. A large installation can handle up to one million computing operations per second.





Telecommunications—the most essential requirement in any successful air defense system. Picture shows antenna installation of a tropospheric scatter circuit in Norway.

Initially, the Mutual Weapons Development Program was used to assist individual countries with the support of specific weapon projects which showed promise. When the idea of setting up an international SHAPE Air Defense Technical Center came along, the Mutual Weapons Development Program was the obvious way to get it started. It was the first use of the program to encourage a common European approach to a problem that was too big for any one nation.

During 1954 a careful survey was made as to where it would be best to locate the Technical Center. The Netherlands was selected. Towards the end of 1954, Government-to-Government negotiations with Holland were completed, and agreements were reached with SHAPE on how the Technical Center would be responsive to SHAPE's requirements. Within the Netherlands, the National Defense Research Organization, RVO-TNO, was selected to establish and provide administrative support for the Technical Center.

The steps of conventional air defense in broad outline are: (1) detection, (2) tracking, (3) interception.

It is hazardous, however, in the close-coupled geography of Europe, to separate air defense from air offense to the same degree as is done, say, in the United States. Europe, geographically speaking, is shoved right up against the muzzle of the Russian gun. To invest too much money in devices to intercept a projectile once the trigger is pulled is questionable economy. It makes more sense to 'get the gun'. This puts a special premium on step (1) detection, or early warning as it is frequently called, for this feeds directly to the offensive forces—the deterrent.

The *SHAPE early warning system* has been under study by SADTC for four years, and many improvements have been suggested. Probably the greatest experts on European early warning are a Canadian, an Englishman, and an Italian —and each minute they have saved could mean thousands of European as well as U.S. lives—for the SHAPE early warning system adds several thousand miles to the reach of North American early warning.

One of the basic aims of SADTC is to make certain no Russian planner can assure his masters that a surprise attack has a good chance of success. Like webs in the sky, electronic threads spread around the iron curtain four thousand miles, from Norway to Turkey. Nature herself conspires on the side of the West, for the position of these threads varies with the weather—and weather prediction, even for the Russians, is far from an exact science. Thus, the greatest military danger to the Free World faced by a hostile dictatorship, the danger of attack without warning, becomes less and less.

Communication is the common denominator of all air defense. Nothing much can be done without it. During the early days of SADTC, a U.S. scientist suggested that the "*scatter*" *communication techniques* just then being perfected in the United States might have special applicability to SHAPE's air defense problems.

The idea caught on. It was decided that SADTC would undertake to contract for, and monitor, the building of a scatter circuit in Norway and another circuit for the southern flank of NATO, running from Paris to Turkey.

"Scatter" is a comparatively new word in the electronic dictionary. It used to be generally thought that the higher frequency radio signals only traveled in straight lines, limiting useful communication ranges at these very short wave lengths to line of sight distances of forty to fifty miles because of the curvature of the earth. Then it was found that with greater powers, some of the energy beamed out towards the horizon was "scattered" back to the earth —from the lower layers of the atmosphere within the troposphere or from the higher layers within the ionosphere, depending on the specific frequency used. Range depended on the height of the scattering layer selected. Thus, "over the horizon" scatter communication was born, and new possibilities opened up in the greatly overcrowded radio frequency spectrum.

The SADTC circuit in Norway, using "tropospheric" scatter, has been completed; the southern circuit, using "ionospheric" scatter, is just about to go on the air. These two circuits are to serve as prototypes for the eventual building of a complete Allied Command Europe military communication system.

Many of the ideas in SADTC's storehouse have come from Canada. Canada brought the concept of the electronic fence; the device that alerts and tells whenever it is crossed. Canada also brought a communication system based on the reflection of radio signals from *ionized meteor trails*. What is done with high powers and large antenna arrays in the ionospheric scatter system is done with low powers and small antennas by reflection from meteor trails. One's first thought is that this must be a most uncertain type of communication, where a message has to wait for a meteor to come along at just the right spot and right time so it can hitch a ride. But it seems that there are more meteors high up in the sky than anyone ever dreamed of. Seldom is it necessary to wait more than a minute or two before a burst of communication can be sent 800 to 1,200 miles.

SADTC has completed a meteor scatter test circuit from Holland to Italy to study the application of this type of communication to air defense on the premise that a number of alternate ways to transmit vital information is the only guarantee of assured communication.

Let's look at interception for a moment. Like the "Dutch auctions" at the flower market in Aalsmeer, air defense aims to make the price to the customer as high as possible.

Scientists from Norway, Denmark, Germany, Holland and Turkey are analysing the pros and cons of various types of weapons for air defense in the NATO area.

France, England, and the United States are backing up SADTC's data handling group with facts about the most advanced types of systems now under development. SADTC has become the focal point in Europe for working out basic technical requirements, so that when nations begin building modern, highspeed data handling systems, information will be able to flow across national boundaries without restriction, and an integrated European air defense system will no longer be a dream, but a reality.

Interceptor aircraft supplied by the United States are dispersed all over Europe and represent an investment of hundreds of millions of dollars. But at today's speeds, the interceptor is comparatively helpless unless backed up over large areas on the ground by an extensive electronic information handling system. If it becomes possible to build such a system in Europe, the value of the U.S. investment will be multiplied many times.

If it seems disproportionate that one of the smaller NATO countries should be selected to develop an organization to cope with such an enormous and difficult problem as air defense, the tenacity and special competence of the Dutch should not be forgotten.

The Netherlands is the land below the sea: about two-fifths of it, anyway, and reported to be still sinking. This does not disturb the equanimity of the Dutch, who have a special "water winning" army standing guard night and day against the constant danger.

Through centuries of experience, the Dutch have learned how to take the great forces of wind, current, and tide, and turn them to their own advantage—causing them to build, rather than destroy, the thin wall of sand dunes and dikes that extend for 1,120 miles and stand between the richest part of their country and the driving sea. In similar vein, there are ways in the realm of electronics whereby hostile power can be used to checkmate itself, and the Dutch have a natural aptitude for thinking of them.

With the advent of missile-launching submarines, the threat of missiles coming from land to the east must be supplemented, in the European viewpoint, by the threat of missiles launched from the sea to the north, west or south. Here is a problem that yields to solution only with an intimate and expert knowledge of the sea. And here is a nation which has been developing such a body of knowledge for twenty centuries.

Some have argued that the defenses the West throws up against Russia as she flows outward over adjacent territories are themselves the cause of all the tension in the world. Reduce these defenses unilaterally, they say, and the cold war will recede.

This argument does not hold much weight with the Dutch. If they had not built dikes against the sea, there would be no Holland.

Book Reviews

Un pilote quelconque, by Jacques Noetinger. Editions France-Empire, Paris, 1959 (French, 315 pages, illustrated).

Jacques Noetinger, well-known French pilot and aviation writer, recounts in a clear and racy style his adventures in several countries. In tones often tinged with emotion he tells of his joys, his enthusiasms, his trials and hardships, and impresses the reader with his great love of flying, his coolness and courage. The reader will be delighted to find many old friends in these pages, which bring to life some of the great figures in aviation. In short, this is an excellent book on flying and a lesson in doggedness, exemplified to some extent by the long months during which Jacques Noetinger was bedridden in hospital as the result of an accident.

Ka

Rocket Encyclopedia Illustrated. Chief Editor John W. Herrick, Associate Editor Eric Burgess, Illustrator Wayne Langford. Published by Aero Publishers, Inc. Los Angeles, 1959 (English; 607 pages; price $12.50).

The easy-to-read explanations together with some 450 photographs and drawings bear ample witness to the five years of study and research that went into this encyclopedia. Rocket power and applications, propellants, engines, assemblies, components, accessories, production, ground equipment, engineering data—all these subjects are broken down into their respective terminologies and discussed in plain English. Included also are biographies of famous rocket personalities.

Some items defined include: closed-circuit filling, cigarette-burning grain, cook-off, optimum expansion, post-fire purge, tie-down firing, "screaming" combustion, etc. Technical slang and sophisticated terms are all described—if you are not sure of what is meant by *choking*, *chuffing* and *chugging* a detailed explanation of these terms may be found on page 88.

There are three features of particular interest; first, a rocket term is summarized followed by a detailed technical explanation. Secondly, *Visual Keying* links keywords in the text with the relevant component in an illustration. This is achieved by printing the word in *bold face* in the description and labelling the component itself with the same terminology. Lastly, where a word is in italics a full explanation appears elsewhere in the encyclopedia.

As Dr. Theodore von Kármán says in his interesting foreword the speed with which the rocket industry has advanced has taxed the brain-power of the scientists, engineers and production workers. Their ultimate target will be achieved when manned space flight becomes a reality.

Tu.

The Soviet Air and Rocket Forces. — Edited by Asher Lee. Published by Weidenfeld and Nicolson, London, 1959. (English; 305 pages, illustrations; price 36 shillings).

An almost impossible task has been undertaken in this book, which reviews not only the evolution and organization of Soviet aviation since the revolution but also the trends for future development. Chapters written by a number of distinguished contributors deal with such subjects as long range air attack, civil aviation in Russia, airborne troops, aircraft production, and politics in the Soviet air force. It has unfortunately been found necessary to rely on estimates when assessing strength in the air but, despite some minor errors of detail, Asher Lee's book is valuable as a guide to past, present and future Soviet policy in aviation.

Pe.

Segelflug. — By Hans Nietlispach. — Published by Josette Nietlispach, Berne, 1959 (German, 151 pages, 55 illustrations, 5 weather charts).

Hans Nietlispach is one of the best-known glider pilots in the world and, what is more, one of that rare breed who can, and do, write about their experiences. His book on gliding, like many others, begins with a concise introduction into its scientific, technical and professional principles, at times, unfortunately, rather sketchy and with some almost alarming generalizations. When dealing with the regulations he becomes more precise, although he does not mention what a glider pilot should do if he sees a red light in the tower when coming in to land. The second part is more interesting. His advice on high performance flight—learn aerobatics before venturing into cloud, instrument flying by the turn and bank indicator only, to give but a few examples —will enable many a pilot to shorten his training period. The third part contains descriptions of long-distance flights from Switzerland, written as excitingly as a thriller and with a wealth of detail hitherto unknown. They contain, however, much that is of value to pilots in other lands, as is amply borne out by the weather charts. This is a book which it is hoped will have a wide circulation and will be the first of many more.

De.

Books received

Berichte der Deutschen Versuchsanstalt für Luftfahrt; distributed by the Zentrale für Wissenschaftliches Berichtswesen der DVL, Mülheim/Ruhr. Westdeutscher Verlag, Cologne and Opladen, 1958/59:

Report No. 76: Über den Brechungsindex von Wasserdampf-Luft-Gemischen bei Dezimeter- und Zentimeterwellen, by M. Vogel (price DM 20 70).

Report No. 78: Berechnung der Beulwerte von Platten unter ungleichmässiger Temperaturbeanspruchung nach dem Mehrstellenverfahren, by W. Schnell and G. Fisher (price DM 11.30).

Report No. 79: Der Einsatz elektronischer Rechenanlagen bei der Lösung funknavigatorischer Aufgaben im Flugzeug und am Boden, by Th. Feger (price DM 26.20).

Report No. 81: Übertragung der Görtler'schen Reihe auf die Berechnung von Temperaturgrenzschichten (Part I), by E. Wrage (price DM 12.80).

Report No. 82: Betrachtungen über einen elektrokinetischen Generator, by A. Walz (price DM 6.60).

Report No. 83: Über den Lärm von militärischen Düsenflugzeugen im Bereich der Umgebung, by F. J. Meister and S. Ruff (price DM 8.90).

Report No. 84: Beitrag zur Näherungstheorie kompressibler turbulenter Grenzschichten, by A. Walz (price DM 14.50).

Report No. 85: Laminare Grenzschichten in der Magnetohydrodynamik, by C. Jungclaus (price DM 8.20).

Report No. 86: Die eingespannte, an den Rädern versteifte, dünne Rechteckplatte mit gleichmässig verteilter Belastung, by O. Volkersen (price DM 17.30).

TRANSPORT AIRCRAFT:

Payload:
4 to 7 tons depending on mission

Take-off and landing run:
less than 100 yards

Speed:
approx. 280 m.p.h.

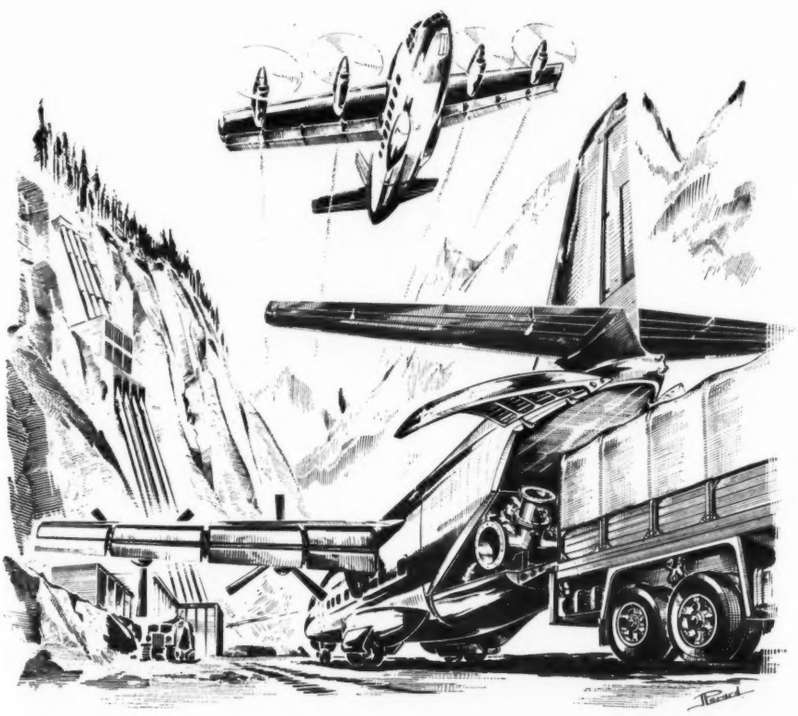
The

BREGUET 941

short take-off aircraft

provides a modern replacement for older equipment

Enables airlines to call at points hitherto inaccessible, thus opening up new operating prospects.



Olé,

Mr. Worldwide!

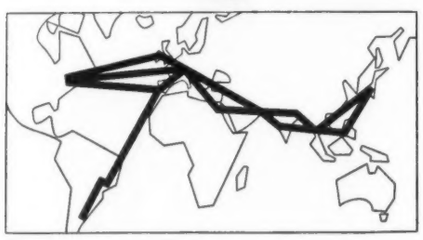
You took it from

the horse's mouth:

Smart people fly

Swissair

... worldwide



Your travel agent will tell you: The fares are all the same: it's the service that's different

SWISSAIR

9th INTERNATIONAL ENGINEERING SHOW

TURIN

September 24th to October 4th, 1959

METALLURGY
GENERAL ENGINEERING
OFFICE MACHINES AND EQUIPMENT
FACTORY MACHINES AND EQUIPMENT
MACHINE TOOLS
GENERAL TOOLS
ELECTRICAL ENGINEERING
ELECTRONICS
NUCLEAR ENERGY
PLASTICS, RUBBER, PAINTS, BONDING MATERIALS
CINEMATOGRAPHY
PHOTOGRAPHY
OPTICS
AGRICULTURAL ENGINEERING
BUILDING MACHINERY AND EQUIPMENT
ROAD WORK — SNOW CLEARING

Associated events

19th International Engineering Exhibition
6th European Plastics Show
11th International Plastics Congress
11th International Cinematographical, Photographical and Optical Exhibition
11th International Cinematographical Congress
11th International Film Week
9th International Agricultural Engineering Show
3rd Competitive Exhibition of Inventions and Industrial Progress
International Meeting of the Technical, Scientific and Periodical Press

Foreign agents

PARIS — Italian Chamber of Commerce in Paris, 134, rue du Faubourg-St.-Honoré — Tel. ELYsées 46.27, BALzac 40.88

FRANKFURT/MAIN — Italian Chamber of Commerce for Germany, Feldbergstrasse 24 — Tel. 774.747 - 774.767

BRUSSELS — Belgo-Italian Chamber of Commerce, rue du Midi 61 — Tel. 12.96.31

AMSTERDAM — J. Leonard Lang, Stadhouderskade 114 — Tel. 719.744

GENEVA — Pondil S.A., rue de la Tour-de-l'Ile 1 — Tel. 25 62 34

WEMBLEY (Middx) — Fiat England Ltd., Water Road — Tel. PERivale 5651

Thank you for your choice

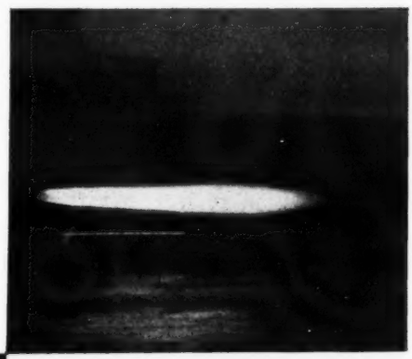
PUBLIALIT 59 F3

ALITALIA

the Airline that
preference built

All techniques concerning liquid-propellant

and solid-propellant rocket-engines

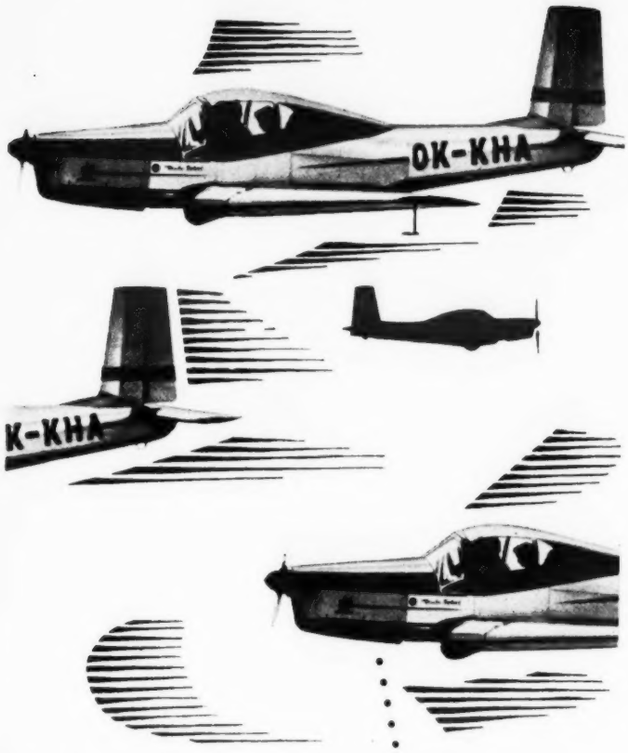


... and test instruments

SEPR

1, VOIE DES SABLES
VILLEJUIF (SEINE)
Tél. : ITA. 57-69

Société d'Etude de la Propulsion par Réaction



By its Appearance and Performance

the CZECHOSLOVAK

L 40 Meta-Sokol

aircraft is especially well suited for sports flying and tourism as well as training.

It is a low-wing, cantilever, four-seater monoplane of monocoque construction with all-metal airframe and a glass canopy providing an excellent view. It is powered by the M332 140 HP.

Apply for **further technical data** and a detailed offer to

OMNIPOL
Washingtonova 11 - PRAHA 3 - Czechoslovakia

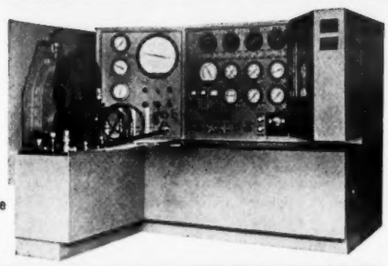
AGENTS : *Argentina :* Dr. Mario Insua, Arenales 1161, Buenos Aires. *Austria :* Ing. Alfred Rutte, Berggasse 16, Vienna IX. *Belgium :* Raymond Heuvelmans, 36, Avenue Albert Jonnart, Brussels. *Brazil :* Cia Latino Americana de material aeronáutico, 141, Praça Julio Prestes, São Paulo. *Denmark :* Hammers Luftfahr, Vestbrogade 54, Copenhagen V. *Federal German Republic :* Autohage G.m.b.H., Schmittstrasse 47, Frankfurt am Main. *France :* E.M.A., 46 rue Jacques Dulud, Neuilly s/Seine. *Great Britain :* Aircraft and General Finance Corporation Ltd., 3 Read Place - Green Street, London W.1. *Holland :* R. Uges Jr. Handelsmaatschappij Het Oosten, Thierenskade 27, Rijswijk Z.H. *Norway :* Aero Electric, Radhusgaten 7 B, Oslo. *Paraguay :* Jorge Laboureur, 25 de Mayo 267-60, Buenos Aires/Argentina. *South Australia :* Phoenix Aviation Co. Ltd., 240, Rundle Street, Adelaide, South Australia.

NANKERVIS TEST EQUIPMENT

Tests Fuel Accessories : FASTER – MORE ACCURATELY

FEATURES

- High production rate (fuel controls for JT-3 engine can be tested in 4 hours)
- Automatic up-stream and down-stream flow regulation
- Automatic down-stream engine simulation
- Vacuum pump (maintains 29" mercury continuously)
- Automatic fuel temperature regulation within 2°F
- Easy to operate
- ½% speed regulation



NANKERVIS TEST STANDS *are built for long dependable use. They have been especially designed for automatic, fast test operation at a high degree of accuracy. Using the Universal Major Fuel Accessories Test Stand above, fuel pumps for the JT-3 or JT-4 engine can be tested in 150 minutes. This is only one of many types of precision aircraft and missile test equipment engineered and produced by the George L. Nankervis Company and available through American Avitron, Inc., exclusive export distributor.*

American Avitron INC.

514 HALSTEAD AVE.
MAMARONECK
NEW YORK

S.F.E.N.A.

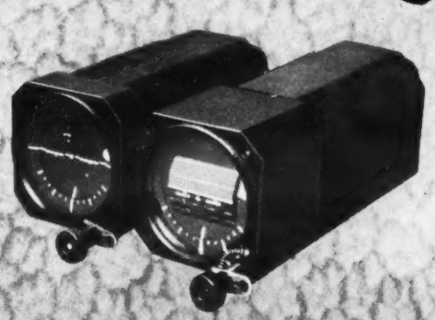
SOCIÉTÉ FRANÇAISE D'ÉQUIPEMENTS POUR LA NAVIGATION AÉRIENNE

DEPARTEMENT ÉQUIPEMENTS

Pilotages Automatiques
Horizons Gyroscopiques
Gyroscopes Directionnels
et Gyromètres.
Compas Magnétiques
Servo-Mécanismes divers
Amplificateurs Magnétiques

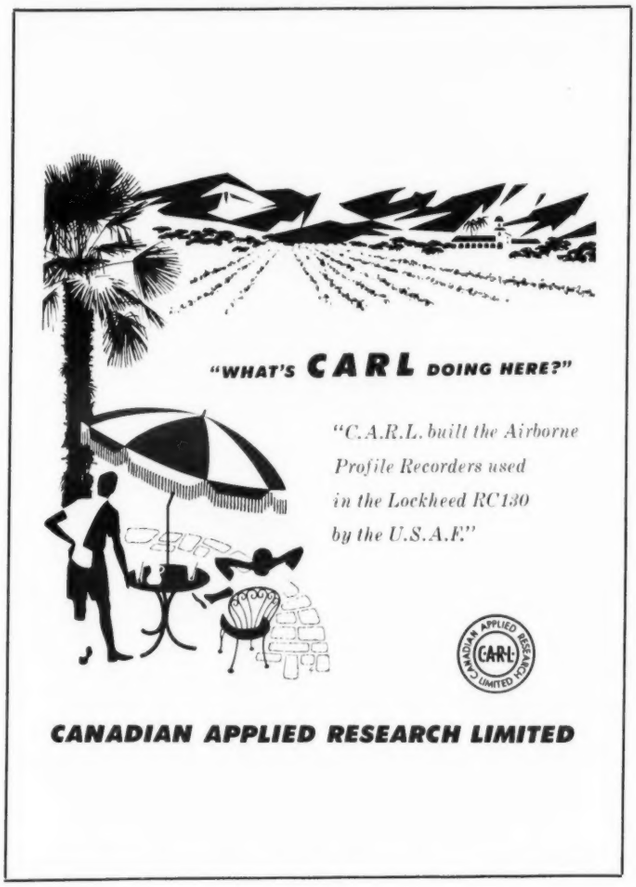
DÉPARTEMENT ÉLECTRONIQUE

Localisation et Guidages d'Avions
et Engins. Télécommandes
et Télémesures



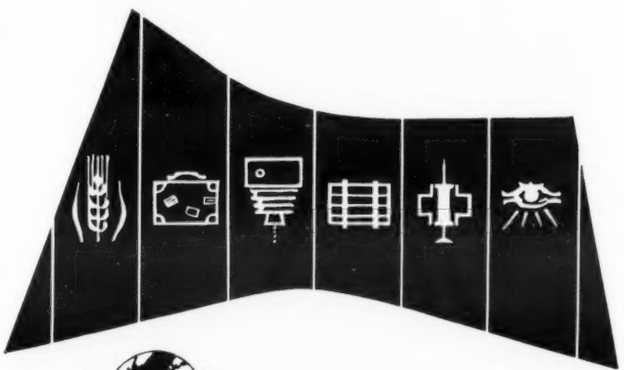
25 à 29, Rue du Pont, NEUILLY (Seine) - Tel. MAillot 49-35 et la suite

Telegrams : AGUSTA-GALLARATE Telephone : 21767 - 21768 - 21409 - 20109


"WHAT'S CARL DOING HERE?"
"C.A.R.L. built the Airborne Profile Recorders used in the Lockheed RC130 by the U.S.A.F."
CANADIAN APPLIED RESEARCH LIMITED

Qualified for each of its many tasks
is the versatile aircraft of Czechoslovak manufacture,
the L 60 BRIGADÝR
with a 220 b.h.p. Praga-Doris engine
OK-JEA

It can be used for: agriculture, ambulance duties, liaison service, glider towing or aerial advertising, passenger and freight transport, aerial mapping, patrol and reconnaissance duties, etc.
Ask for a special offer with further particulars of the *advantageous features of the L 60 BRIGADÝR.*



OMNIPOL
Washingtonova 11
Praha 3
Czechoslovakia

AGENTS : *Argentina :* Dr. Mario Insua, Arenales 1161, Buenos Aires. *Austria :* Ing. Alfred Rutte, Berggasse 16, Vienna IX. *Belgium :* Raymond Heuvelmans, 36, Avenue Albert Jonnart, Brussels. *Brazil :* Cía Latino Americana de material aeronáutico, 141, Praça Julio Prestes, São Paulo. *Denmark :* Hammers Luftfahr, Vestbrogade 54, Copenhagen V. *Federal German Republic :* Autohage G.m.b.H., Schmittstrasse 47, Frankfurt am Main. *France :* E.M.A., 46 rue Jacques Dulud, Neuilly s/Seine. *Great Britain :* Aircraft and General Finance Corporation Ltd., 3 Read Place - Green Street, London W.1. *Holland :* R. Uges Jr. Handelsmaatschappij Het Oosten, Thierenskade 27, Rijswijk Z.H. *Norway :* Aero Electric, Radhusgaten 7 B, Oslo. *Paraguay :* Jorge Laboureur, 25 de Mayo 267-60, Buenos Aires/Argentina. *South Australia :* Phoenix Aviation Co. Ltd., 240, Rundle Street, Adelaide, South Australia.

The latest **BELOTTI Type B.5,** self-propelled pneumatic runway sweeper

is in service at Rome's Ciampino Airport and is indispensable at all airports used by jet aircraft.

An area of 1,185,000 sq. ft. can be swept in an hour.
Suitable for runways, access roads, taxiways, aprons.

Since 1953 the BELOTTI company has been manufacturing pneumatic sweepers specially designed for airport use, and the B.5 model is the fruit of this experience.

BELOTTI Truck-Mounted Cranes - Other Vehicles
Via Francia 20R - GENOA - Tel. 62.923
Plant: Genoa - Sampiedarena - Tel. 451.990
Export Office: Via Passeggiata 35, ROME - Tel. 672730

Fine Art Process Engraving Works

Schwitter Ltd

Basle
Allschwilerstrasse 90
Telephone 061 38 88 50

Zurich
Stauffacherstrasse 45
Telephone 051 25 67 35

Lausanne Office
Avenue de la Gare 44
Telephone 021 22 86 75

MATRA

SPECIAL MISSILES
ROCKET LAUNCHERS
AUTOMATIC PILOTS

27, Quai de Boulogne BOULOGNE S/SEINE MOLitor: 60.10

Stabilimenti Meccanici Riuniti S.p.A.
Share Capital Lire 500 000 000
Offices in Livorno, Italy

WHITEHEAD - MOTO FIDES

Manufacturers of:
Torpedoes
All types of weapons
High pressure compressors
Anti-submarine and anti-aircraft rockets
Hydraulic control systems
Precision components

CLICHES RICHTER S.A.

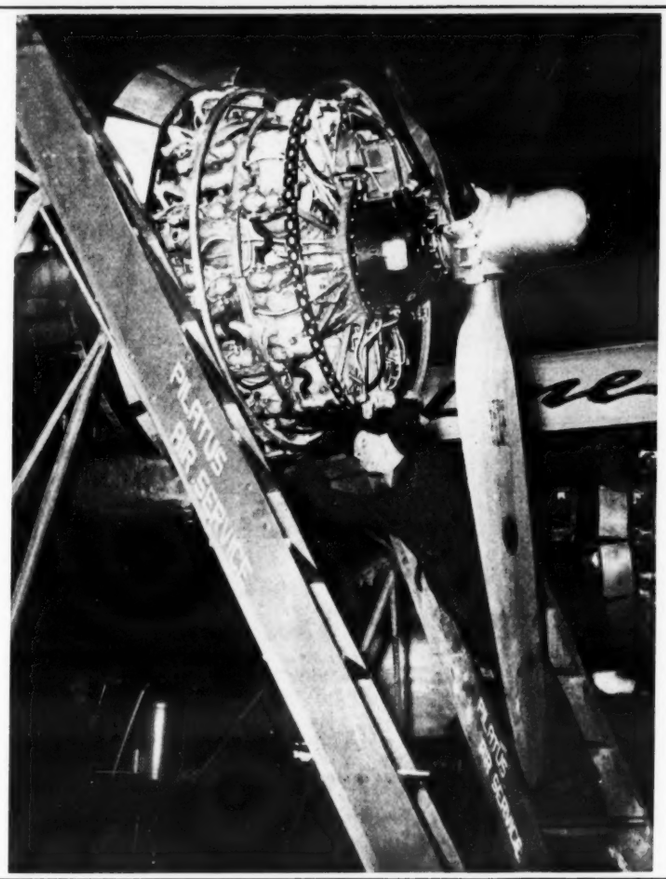
GENEVE

A Short Guide to Radio Navigation and Air Traffic Control

English, French, German and Spanish (1958 Edition)

Available in three editions with main text in either English, French or German. 24 pages ; 31 diagrams ; 2 tables ; glossary of English/American abbreviations ; 9 ¼" x 6 ¾" ; Price US $ 0.80 or Sterling £0. 4s. 6d, postage extra.
A four-language key to the art of Air Navigation and Air Traffic Control.

PUBLISHED BY:
INTERAVIA . GENEVA 11



Handling and maintenance for taxi operators and charter passenger and freight carriers. Overhaul and repair of sports aircraft.
Specially equipped electronics department at Zurich-Kloten for all IFR and VFR radio equipment. Repairs to all VHF navigation and airborne systems.— Approved by the Swiss Federal Air Office.

PILATUS

Air-Service

Zurich-Kloten: Telephone (051) 93 73 87
Geneva-Cointrin: Telephone (022) 33 53 65

Dependability, reliability and economy, short take-off and landing distances, highest comfort and convenience with a cruising speed of over 500 m.p.h.
These are just some of the advantages of the

TYP 152

a product of the aircraft industry of the
GERMAN DEMOCRATIC REPUBLIC
We supply aircraft, aircraft equipment, aircraft accessories, airport equipment and ground installations of tested and proven quality.

TECHNOCOMMERZ
GmbH

BERLIN N 4, FRIEDRICHSTRASSE 110-112 - TELEGRAMS: TECHNOCOMMERZ BERLIN - TELEX: 011-480 TECHNOCOM BLN - TELEPHONE: 42 52 96

List of Advertisers in 'Interavia' No. 7, 1959

Aero Design & Engineering Co., Oklahoma . . 833
Aircraft Dynamics, New York 878
Air France, Paris 775
Air Trainers Limited, Aylesbury 851
Alitalia, Rome 873
Alvis Limited, Coventry 771
American Avitron Inc. (George L. Nankervis Co.) Mamaroneck 874
Armstrong-Whitworth Aircraft, Ltd., Coventry 791
Atlas Copco A. B., Stockholm 834

Bell Helicopter Corp., Fort Worth 828
Belotti, Genoa 876
Bendix International, New York 826/27
B. & H. Instruments Co., Fort Worth 829
Blackburn & General Aircraft Ltd., Brough . . 798
Boeing Airplane Co., Seattle 783
Breguet (Avions) Louis, Paris 871
Bristol Aeroplane Co. Ltd., Bristol 784/85
Bristol Siddeley Motors Co., Bristol 781
British Petroleum Co. Ltd., London 830

Canadair Limited, Montreal 856/57
Canadian Applied Research Ltd., Toronto . . 875
Canadian Westinghouse Company Ltd., Hamilton 801
Cointrin Airport, Geneva 860
Collins Radio Co., Cedar Rapids 879
Contraves Italiana S.p.A., Rome 854
Convair, San Diego 770
Costruzioni Aeronautiche Giovanni Agusta, Cascina Costa (Gallarate) 875
Curtiss Wright Corp., Carlstadt, N. J. 777

Decca Navigator Co. Ltd., London 778
Decca Radar Ltd., London 825
Deutsche Lufthansa AG., Cologne 773
Douglas Aircraft Co. Ltd., Santa Monica . . . 797

The English Electric Co. Ltd., London 806
Esso Export Corp., New York 880

Fiat S.p.A., Turin 774
Firestone International Co., Akron 795

General Precision Laboratories Inc., Pleasantville 831
Gilfillan Bros., Los Angeles 782
Goodyear International Corp., Akron 805

De Havilland Aircraft of Canada Ltd., Montreal 855
De Havilland Engine Co. Ltd., Leavesden . . . 788

Iberia, Madrid 878

Lear Inc., Santa Monica 832
Lockheed Aircraft Corp., Burbank 859

Marconi's Wireless Telegraph Co., Chelmsford 792
MATRA, Boulogne s/Seine 876
Minneapolis Honeywell Regulator Co., Minneapolis 793
Murphy Radio Limited, Welwyn Garden City . . 772

D. Napier & Son Ltd., London 802
Nord-Aviation, Châtillon s/Bagneux 803
Northrop Aircraft Co., Hawthorne 852/53

Omnipol S.A., Prague 874, 875

Philips, Hilversum 861
Pilatus Flugzeugwerke AG., Stans 877

Republic Aviation Corp., Farmingdale 794
Clichés Richter S.A., Geneva 876
Rotol Limited, Gloucester 787

Salon de la Technique, Turin 872
Clichés Schwitter S.A., Basle 876
SEPR, Villejuif (Seine) 873
SFENA, Neuilly 874
SNECMA, Paris 796
Ad. Strüver G.m.b.H., Hamburg 799
Sud-Aviation, Paris 776
Swissair, Zurich 872

Technocommerz G.m.b.H., Berlin 877
Thomson-Houston, Gennevilliers 858

United Aircraft Export Corp., East Hartford . . 804

Vickers-Armstrongs Aircraft Ltd., London . . . 800

Whitehead-Moto Fides, Livorno 876
Willys Overland Export Corp., Toledo 786

REPRESENTATIVES WANTED

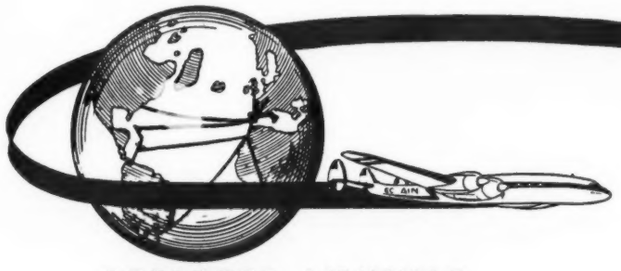
Leading U.S. Aviation MFG. & Stockists of diversified aircraft, engines, & spare parts seeks established import representatives to service airlines, airforces & aviation manufacturers in their area.

AIRCRAFT DYNAMICS
666 Fifth Avenue, New York

The Custer Development Establishment is in urgent need of

Helicopter Pilots and Mechanics

All interested please airmail express letter of employment availability and qualifications to Interavia, 6 Corraterie, Geneva 11, Switzerland. Replies will be handled with utmost discretion.

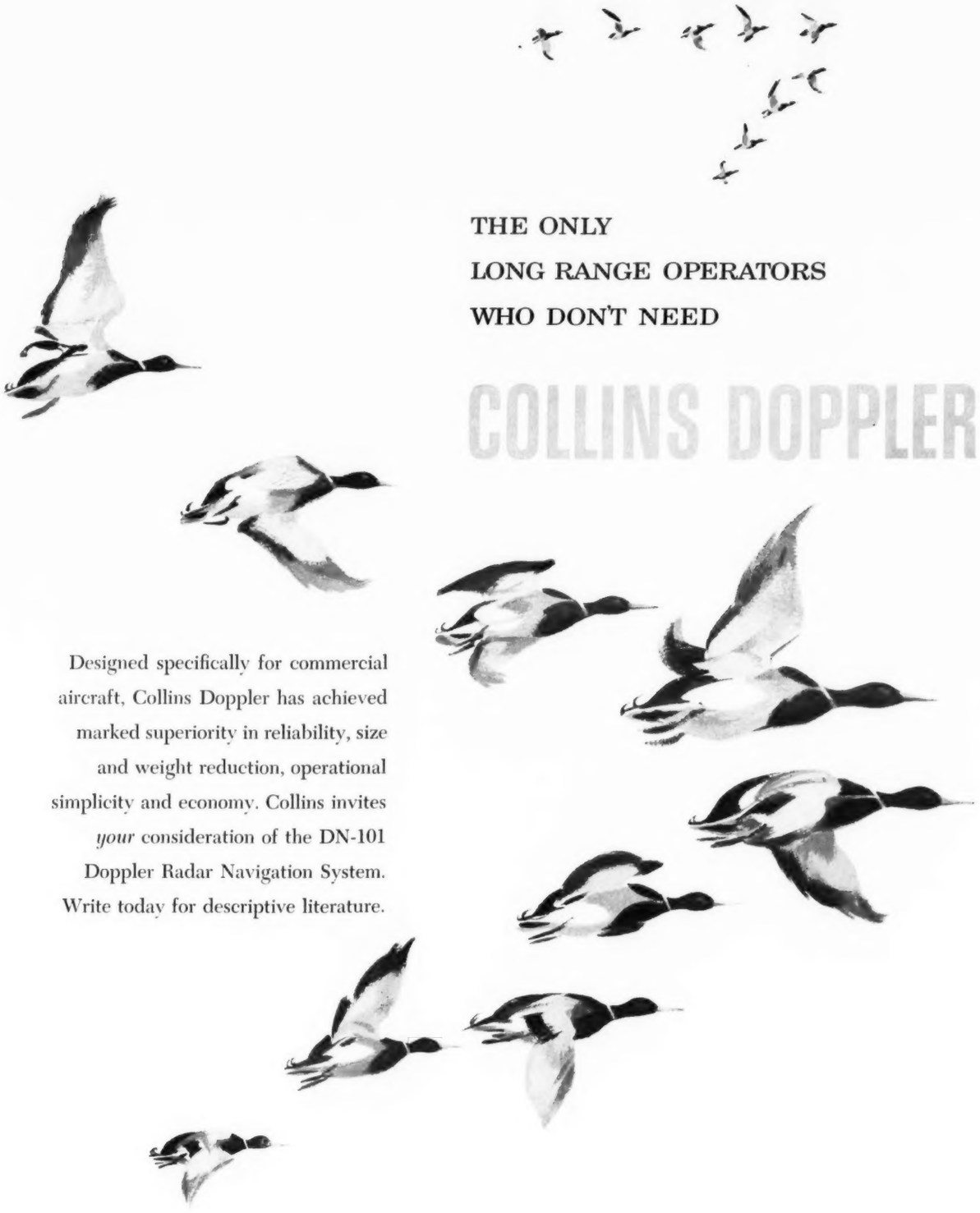


SERVICES LINKING
4 CONTINENTS

Iberia
LINEAS AEREAS ESPAÑOLAS

Paper : Papierfabrik Biberist • Cover, four-colour printing and photogravure : Fabag Druck Zurich • Letterpress printing : Imprimerie de La Tribune de Genève

Printed in Switzerland



THE ONLY
LONG RANGE OPERATORS
WHO DON'T NEED

COLLINS DOPPLER

Designed specifically for commercial aircraft, Collins Doppler has achieved marked superiority in reliability, size and weight reduction, operational simplicity and economy. Collins invites *your* consideration of the DN-101 Doppler Radar Navigation System. Write today for descriptive literature.

COLLINS

COLLINS RADIO COMPANY • CEDAR RAPIDS, IOWA • DALLAS, TEXAS • BURBANK, CALIFORNIA

Pan American 707

Saving precious time for airlines:

HOW ESSO DOES IT!

All airlines see record expenditures in the jet age. Turn-around time is a major factor . . . extra minutes on the ground could cost hundreds of dollars in lost revenue. Esso is helping to cut this costly ground time to the minimum by supplying the fuels, lubricants and *service* that will assure airlines bigger dividends from their investment in jet age equipment.

To help speed turn-around, Esso pioneered safe, high-speed hydrant fueling—now in use at many major airports worldwide. And Esso developed large-capacity mobile refuelers with extra-fast pumping rates.

Esso service crews everywhere benefit from Esso's Jet Age Training Program—most advanced and comprehensive in the industry. *Wherever* you see the Esso sign, you can depend on quick, careful and competent service.

INTERNATIONAL AVIATION PETROLEUM SERVICE

ESSO